AMERICAN ENGINEER AND RAILROAD JOURNAL.

JANUARY, 1901.

CONTENTS.

ILLUSTRATED ARTICLES:	Page
The Large Steel Car	1
Effective Lubrication of Driving Boxes	4
Center Plates, by Edward Grafstrom	6
New "Empire State Express" Locomotive	8
Low Drop-Bottom Gondola Car, 80,000 Pounds Capacity	9
New Shops of the Colorado & Southern Railway	10
Four-Wheel Steel Frame Truck and Steel Frame Draft Gear	12
Vauclain Compound Consolidation Locomotives	15
Some Convenient Car Shop Devices, by Oscar Antz	18
Improved Joint for Piston Packing Rings	19
Cafe-Parlor Car for Fast Express Service	20
Johnson's Locomotive Valve Lubricator	20
An Improvement in Oil Cups	21
Westinghouse-Parsons Steam Turbine	23
A Modern Roundhouse	25
Self-Opening Car Windows	27
Tests of the Boiler of the Purdue Locomotive, by W. F. M. Goss	28
The Dayton Twin-Spring Draft Gear	30
Metal Window Casings	32
Electric Conduct Applied to Cable Railways	34
ARTICLES NOT ILLUSTRATED:	
Baldwin Locomotives for France,	5
A New Record on the Lehigh Valley	5
Locomotive Museum	7
Broad View of Locomotive Design	11
High Speed Suburban Service by Water	14
Changes Among the Railroad Papers	14
United States Mail Service	15
American Society of Mechanical Engineers	17
Locomotive Classification	21
Arrangement of Views on Drawings	21
Small Steel Castings and the Tropenas Process	32
EDITORIALS:	
Position of the Large Steel Car in Railroad Improvements	16
Wheel Arrangement for the Future Heavy Passenger Locomotives	16
Center Plates and Side Bearings	16

THE LARGE STEEL CAR.

Its Development and Position in the Business of Railroads.

By W. S. Morris,

Superintendent Motive Power, Chesapeake & Ohio Railway.

As we observe the different avenues of progress in locomotive and car construction, one cannot help but be taken with the general fitness of detail which seems to prevail with engineers in the design of cars and locomotives. The tendency toward increased weight and tractive power in machines is on the other hand met by the car problem, "Of carrying the greatest amount of paying load with a minimum tare and without sacrifice of strength or durability."

A casual glance at the motive power of this country will show an increase of from 25 to 50 per cent. in capacity over engines of ten years ago, and the train load has increased in as great rate as the railroads changed from the car unit to a ton unit. For example:

In 1890 the heaviest consolidation engine in use on our mountain freight trains on the Chesapeake & Ohio had 114,000 lbs. upon the drivers and developed a tractive power of 28,800 lbs., with 21 by 24-in. cylinders and carrying 160 lbs. steam pressure. In 1895 a machine with 121,700 lbs. on the drivers was introduced, and in 1899, the present "G6" consolidation engine, having 172,500 lbs. on drivers, with cylinders 22 by 28 ins. and a tractive power of 41,150 lbs., with 200 lbs. of steam, has displaced the machines of earlier birth—an actual increase of tractive force of engines since 1890 of 12,350 lbs., or 33 per cent.

The heavier trains now handled soon developed the fact that stronger cars, better draft rigging and more complete braking power were necessary. Extended experience in the design and construction of the wooden car with its accompaniments had established well-seated prejudices, and it is not to be wondered at, that other experiences, absolutely convincing in their nature, must be weighed before the new car may be realized, as it displaces to an enormous extent well-established practices that have appealed to our best judgment and yet wield a very strong influence under certain conditions.

In my own experience on some of the Western roads the use of wood for fuel for locomotives furnished means of livelihood for the inhabitants, and the great virgin forests being at the very door of the railroad shop, metal for car construction was only introduced where timber could not be used. I can well remember when the requirements of one of our prominent Western roads for freight-car construction necessitated the carrying of all timber four years before it would be accepted in car construction. What would a car cost to-day under these specifications, and would it be possible to get it at all?

The responsible operating officer has only too well realized the experiences that demonstrate, without further experiment, that design for construction must almost reach the line of indestructibility and yet accomplish maximum carrying results, and the factor of safety must be as high as reasonable weights will admit.

Every railroad yard tells its own story of rough handling, and accidental or service damage; but with the M. C. B. coupler eliminating the necessity of manual direction of the coupling link and pin, the old-time operator or switchman witnesses many a disastrous shock and shiver of timbers, greatly exaggerated, no doubt, from the very fact that he is not obliged to go between the cars to make the coupling, thus almost, if not quite, establishing a ready bumping post of each individual car in busy shifting, thus sacrificing wooden parts that have served for many years and have been considered ample in their respective dimensions.

Metal draft rigging has been introduced in connection with wooden framing and numbers of buffing arrangements are offered to relieve destruction upon the wooden car, all indicating their useful advantages, but when by fierce competition freight rates were reduced to a figure that invited loss under old methods, the unit of train tons forced the issue between the respective conditions of car construction, and the result simmered down to the combination that is best suited in weight for maximum carrying capacity.

It is interesting to follow the evolution of the freight car from its early introduction, when about 7,000 lbs. and a four-wheeled car was considered the proper "goods wagon," up to our time, and note what the development of commerce has forced upon the engineer for provision to meet its transportation demands. Coal cars in 1860 carried five tons, and merchandise cars were built to carry about the same weight; and, as late as 1865, 15,000 lbs. was considered an ordinary load for a box car. I can remember, as an apprentice, in 1874, fitting wheels for new box cars, the weight of which was about 19,000 lbs. and their capacity fourteen tons; the twenty-ton car introducing itself in 1876; the twenty-five ton in 1883, and the thirty-ton car in 1885; but not until 1895 was the forty-ton car thought necessary, while now we have the fifty-ton car, made of steel, carrying 10 per cent. above its marked capacity, the tare being less than 25 per cent. of the total weight of car and lading.

In this country the use of steel cars is of but recent date, notwithstanding for almost forty years patents have been taken out for cars made entirely of metal or of wood and metal.

In 1869 R. Montgomery, of New York City, patented a metal car in which corrugated iron was used extensively to form the uprights and roof supports in the form of an arch, and this car was covered with corrugated iron. The floor was formed of arched corrugated iron, set between the transverse girders of the under frame. Such cars seem not to have been used extensively. In 1870, G. C. Bestor patented a passenger car having commercial-shaped metal uprights, mainly channel

bars, with a covering of sheet metal on the inside, outside, top and bottom, so as to form air spaces, and he called this a fireproof car. In 1884, J. T. Goodfellow produced a car with a tubular trussed underframe and wooden body. In 1889, Hughes patented a car having an underframe made of rolled and trussed sections, trussed steel uprights and plates riveted to the uprights. In 1876, Kimball, of Philadelphia, patented a car with a metal frame, to which the wooden sidings were attached. In 1863, Merrill also patented a car with a metal underframe and metal body frame, to which uprights were then attached. In 1888, H. C. Hodges, of Detroit, patented a very ingenious car, with a steel underframe and having a body constructed with sheet metal uprights, having vertical grooves for stiffening and strengthening purposes. In 1892, Burton, of Wichita, Kan., patented a freight car having a metal frame for the box and a wooden or metal covering. In 1889, M. A. Zurcher patented a railway car having a trussed frame in the nature of a bridge truss, supported at each end by a truck. This ingenious bridge construction applied to railway cars, however, did not come into general practice, more than did any of the other cars heretofore described.

C. T. Schoen, of the Pressed Steel Car Company, in 1890 patented a pressed angle piece for the corners of wooden cars. In 1890 appears his first patent, taken jointly with J. M. Hansen, for a car with a steel frame and vertical plates riveted to the same and strengthened by means of rolled metal. Mr. Schoen has patented a number of cars, the essential features of which are the use of pressed steel for the side-walls, uprights, struts, etc.

F. H. Rapley, of the Fox Pressed Steel Equipment Company, patented a car having side walls formed of flanged metal riveted together and thus forming the side of the underframe.

In 1900, Coolbaugh & Dingertz patented their car, which was exhibited at Saratoga, having a steel underframe, a body frame of rolled metal sections riveted together through the flanges and secured to the corners in corner posts adapted especially for the purpose. The American Car and Foundry Company have built a few cars with a frame made up of built-up struts, posts and braces of rolled iron, and supporting a hopped body of extreme height.

The only steel car that has been used extensively is the "Schoen" car of the well-known type, both as a hopper and a gondola. A characteristic feature of the "Schoen" car is that everything is made of pressed steel.

Combination wood and metal are to-day offered by some constructors in a conservative way. Channel frames and plates are now in common use in freight-car construction; but pressed steel shapes at the present time have evidently captured the greater number of freight cars constructed wholly of metal, introducing itself in such uneven proportions with all others as to warrant its adoption without further timidity on the part of the railroads.

One hears many criticisms when bold enough to adopt the new methods, among which are the oxidation and the necessary repairs from casualty being the paramount forecasts of what must be provided for in shop practice; but the ability of the steel car to carry a paying load with a minimum tare and its stability to withstand abuse without actual derailment no one seems to question.

Deterioration due to oxidation cannot at this time be absolutely determined for the steel car, but it is reasonably estimated to be within economical limits when the car earnings of the equipment are compared. As to repairs, the evolution of our bridges and ships can be cited as a comprehensive example of the change of treatment in shop practice.

Car shops and workmen adapted and trained for wood working can be gradually adapted and prepared to meet the new requirements, as the later car construction and repairs introduce themselves, without any serious realization of plant extravagance. Woodworkers will readily turn their hands to metal and render quite equal results, a fact demonstrated in our tender frame shops, originally arranged to build wooden frames, but now working metal entirely when new frames are substituted.

It is true the majority of steel cars now in service are built for coal, ore and like traffic, and what better argument can be advanced for their graduation into other classes of freight equipment? Surely no more severe service can be imagined.

The latest production of wooden car for heavy carrying capacity we have presented in the "Canda" 100,000-lb. capacity box and coal car, which appeals to me as the ideal of wood construction, and in its makeup no effort has been spared in selecting the very best material obtainable, in order to promote strength and the reduction of sizes for a minimum tare. The engineering ability displayed in the combination of the "Canda" car has certainly produced symmetrical results and is a credit to the designer, and yet the question of the life of this car under varying conditions of weather and severe service under heavy loads does not indicate the same stability as that of the steel car, but it does indicate a positive limit to which careful engineering can go in the direction of wood combination in a freight car, while the field of the steel car is limited only by the superstructures and roadway over which they may be operated.

It will be observed in comparing metal designs for freight cars that a structural car made exclusively of standard shapes will necessarily have excessive dimensions if an evil of great consequence is avoided, that of an abnormal number of rivets, which, of course, means increased tare, and while it is true that the structural car will act as a most important factor in the lines of competition in the advent of the metal car, it must be admitted that pressed steel enhances uniformity and strength in girders, without waste of material for car shapes, and a reduction of weight is effected by its selection for freight-car construction.

Some very interesting information is presented by the president of one of the roads using pressed steel cars extensively, and no doubt indicates definitely the true value of that combination. The opinion reads as follows:

"The advantages of the steel car over the 60,000 capacity wooden gondola are so numerous that it is almost impossible to enumerate them. The cost of maintaining the running repairs to wooden cars is greater, and in order to verify this statement it will only be necessary to take for example, 46 of the steel cars to carry the tonnage that 72 wooden 60,000 capacity cars would carry. It therefore cuts down time and expense in the inspection, oiling, and the wearing of the following parts: rails, wheels, brasses, axles, couplers, brake shoes and also in lubrication.

"The comparative cost of repairs due to wrecked cars would be 33 per cent. in favor of the wooden cars; however, this is more than off-set by the fact that what would damage or destroy a wooden car would not damage a steel car to any extent; in other words, the annual cost of repairs to steel cars on account of wrecks would be much less than that of the wooden cars, and if the steel cars were used entirely, the number of wrecked cars would be greatly diminished.

"The saving made and the advantages to be derived in transportation by the use of the steel cars as against the wooden cars are hard to calculate or determine exactly, but we find from a test made that in order to move 1,500 tons of freight in wooden 60,000 capacity cars we are obliged to move 62 more tons of dead weight than if the freight was in steel cars. It would take 30 steel hopper cars to move this, while it would require 47 60,000 capacity wooden cars. The percentage in favor of the use of steel hoppers in length of train would be, therefore, about 28 per cent., or 17 cars. The train expense in handling this tonnage would be the same, but as we increase the tonnage, we decrease train expenses, for example: We could handle 2,000 tons of freight in the steel cars with the same expense that we would have in handling 1,500 tons in wooden 60,000 capacity cars and would require seven cars less;

in other words, we find that 2,000 tons of freight can be moved in 40 steel cars, while it would take 47 wooden 60,000 capacity cars to move 1,500 tons. There would, however, be 112 more tons of dead weight.

"The relative cost of handling the two classes of cars at mines and terminals, of course, is greatly in favor of the steel cars in switching, side-track room and loading, each steel car holding 20 tons more. It would take 10 steel cars for 500 tons, while it would take 17 wooden 60,000 capacity cars for the same tonnage. The expense of loading would be decreased at least 10 per cent., caused by the movement of cars and switching additional cars. The cost of unloading at docks aggregates about 30 per cent. less in favor of the steel car, while the saving in switching and side-track room would be at least 25 per cent. Returning empties to the mines for loading, for the same expense we can move 60 steel cars (dead weight 1,050 tons) as we would have in moving 50 wooden cars of the same capacity (dead weight, 1,050 tons). In other words, we can move a train of steel cars with a carrying capacity of 3,000 tons for the same expense as to move a train of wooden cars with a carrying capacity of 2,500 tons. The cost of transportation in handling 40 steel cars containing 2,000 tons of freight would be the same as 1,500 tons loaded in wooden 60,000 capacity cars. The earnings per train mile would be, for steel cars $11, and for wooden cars $6.59; that is, we would have the same expense in transportation to earn $6.59 per train mile in wooden cars that we would have to earn $11 per train mile in steel cars, or a difference of $4.41 per train mile in favor of the steel cars. This simply refers to the train expenses and not to the wear and tear on the extra wooden cars that would be necessary to handle 1,500 tons as against 2,000 tons in steel cars.

"We demonstrate the saving in power, wages, cars, oil, etc., as follows: We will take 1,000 loads to be moved in steel hoppers and the 60,000 capacity wooden gondolas. To move this number of loads, containing 62,500 tons in steel cars, would require 25 trains; to move the same tonnage in wooden cars would require 31 trains and 1,457 cars. The dead weight of the steel cars would be 17,500 tons, and of the wooden cars 18,213. Therefore, to move the same tonnage in the different kinds of cars it will require 1,457 60,000 capacity wooden cars with a dead weight of 18,213 tons, and 1,000 steel hoppers with a dead weight of 17,484 tons, a saving of six trains and 729 tons less dead weight in favor of the steel cars."

Some very attractive deductions are made in a paper by Henrik V. Loss, presented to the International Railway Congrees at Paris last summer, entitled "A New Epoch in the History of Railway Transportation," which I recommend to railroad officers for careful reading if they contemplate equipment of high-carrying capacity and minimum dead weight. In conclusion it may also be of interest to present the following extracts from a report upon "Cars of Large Capacity," made by General Manager Loree, of the Pennsylvania Lines, to the same congress.

The large car, from a weight-carrying standpoint, seems every way desirable for many lines that have special traffic, such as ore, coal, stone, brick and metal, where the cars can be made to carry full loads in at least one direction. Every railroad of importance in the United States has spent large sums of money in reducing grades, improving alignment and remodeling yards. The weights of locomotives are being constantly increased, and to get the greatest earning power from these locomotives, and to secure the benefit of the large sums expended in improvements of road, it is necessary to have cars that will carry the greatest possible load without increasing the length.

There is a very large tonnage of ore and coal handled between the Great Lakes and the furnaces and mines located 150 to 200 miles distant therefrom. The ore is brought from Lake Superior regions in vessels, and transported from the various ports of Lake Erie to furnaces, from 50 to 60 per cent. being forwarded direct from the vessels to the furnaces in cars without first being stored at the docks. These vessels a few years ago were of a maximum capacity of from 2,500 to 3,000 tons; now they carry as much as 8,500 tons. A quick despatch is required on the part of the vessel owner, which, under conditions prevailing five years ago, would be impossible, but by the use of the 100,000-lb. capacity car it has been accomplished, and the railroad companies are handling a much heavier tonnage over the same tracks, and, notwithstanding the earnings per ton-mile have been greatly cut down, they have been able to maintain a margin of profit.

A careful record taken of nearly 200,000 cars handled on two lines of railway leading from Pittsburg to two of the principal ports of Lake Erie shows that it was possible to secure the following loads for their cars:

Ore, 108 per cent. of marked capacity.

Coal, 82 per cent. of marked capacity.

3,616 of the 100,000-lb. capacity cars showed an average lading carried of 93 per cent.

136 of the 70,000-lb. capacity cars showed an average lading carried of 91 per cent.

6,727 of the 70,000-lb. capacity cars showed an average lading carried of 97 per cent.

Thus proving most conclusively that it was true economy under such conditions to build cars of greater capacity than 60,000 lbs.

The advantages gained by reducing the length of the train for a given tonnage, which are secured by the use of large capacity cars, are:

First.—The friction and atmospheric resistance are lessened, and by bringing the moving load closer to the locomotive it can be handled with greater ease.

Second.—A less number of cars and locomotives are required to move a given tonnage, saving interest on capital and car service, and lessening the empty-car movement in the direction contrary to the heavy-traffic movement.

Third.—The necessity of increasing the capacity of the main lines, freight yards and shops is avoided, and at the same time the cost of switching is reduced.

Fourth—A large saving in wages results from the decreased number of trains.

Mr. Loree further says: "In 1895 the capacity was again increased by the building on the part of the Pennsylvania Lines West of Pittsburg of a large number of 70,000-lb. capacity self-clearing cars for the lake coal and ore trade; the forerunner of the 100,000-lb. capacity steel car, built on the same general lines, and which is now the recognized standard car for this class of traffic. It is largely by these means that the railroads have been able to reduce the cost per ton mile to a figure thought to be impossible several years ago."

On the line which I am connected with, the Chesapeake & Ohio, we started with the 80,000-lb. capacity wood car in 1897, building 100 self-clearing hopper bottom gondolas, since which time we have built of the same capacity 1,000 in 1898, 800 in 1899, and 1,500 in 1900. Our last order for new coal car equipment being 600 of the pressed steel 100,000-lb. capacity self-clearing hopper bottom C. & O. type coal cars.

The transmission of electric power over a line 153 miles long has been successfully accomplished by the Snoqualmie Falls Power Company, at Seattle, Wash. This plant is second in size to that at Niagara, the present output being 10,000 horse-power, which is distributed in and around Seattle and Tacoma. For the long distance test the various lines were coupled together in a continuous circuit beginning at the falls, running to Seattle, back to the falls, thence to Tacoma and back again to the falls. In regular service the transmission is 32 miles to Seattle and 44 miles to Tacoma. The current was furnished by a Westinghouse 1,500 kw. generator. The voltage was 30,000 with a total drop of 25 per cent.

EFFECTIVE LUBRICATION OF DRIVING BOXES.

It is generally understood by many who have experimented with methods of lubrication whereby oil is introduced at the sides of driving axle brasses, that an improvement may be made upon the admission of oil at the top or most heavily loaded portion of the bearing. It is also considered desirable to avoid the use of the oil cavity and oil holes at the top altogether. The problem is to introduce oil at the side or lightly loaded portions without danger of obstruction of the oil grooves by dirt and waste. In our October number, page 315, an interesting car journal brass was illustrated, which seems to be suggestive in this connection, in that it does not employ oil holes or grooves of any kind to get oil to the bearing surface (the holes in the top of the bearing being used merely to circulate the oil). We do not see why the same plan should not succeed in driving boxes. It is a very simple device and is apparently worth trying.

On many roads the top oiling method is still in use, but many admit that the arguments for side oiling are strong. They are watching experiments in this direction before trying it themselves. To them the accompanying engravings will be interesting because they bring out several ideas which seem important.

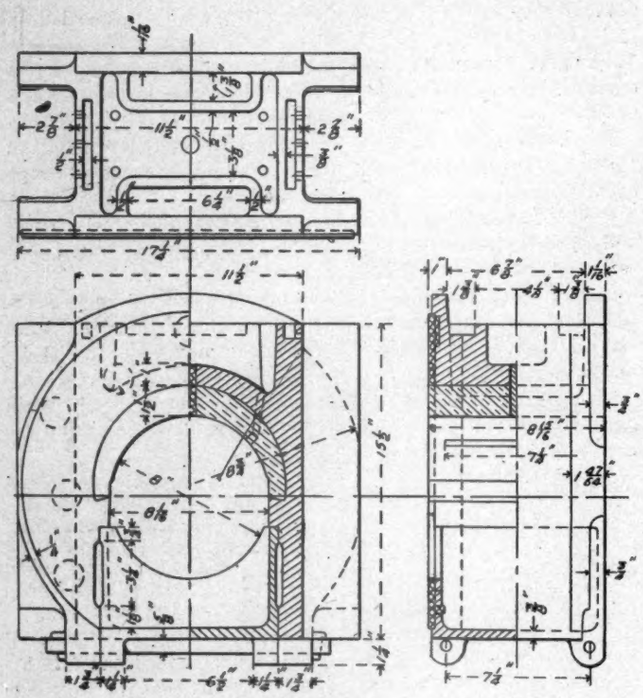


Fig. 1.

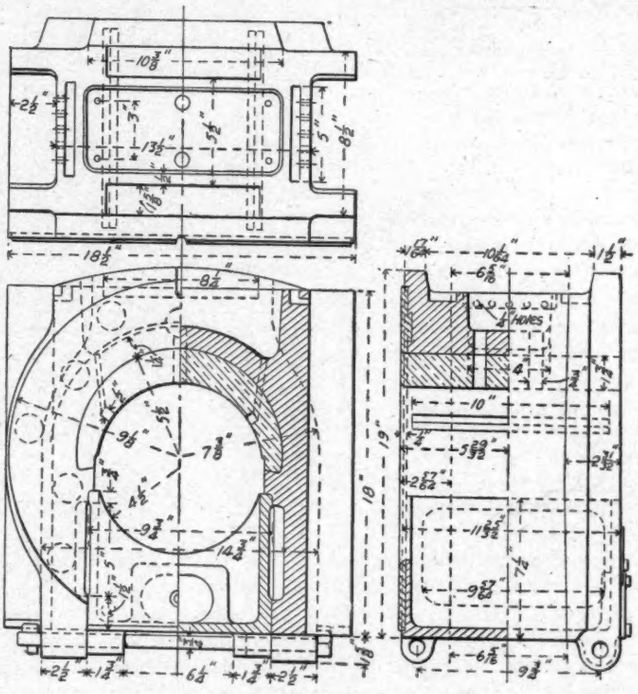


Fig. 2.

The Master Mechanics' Association committee, reporting upon this subject last June, recommended slotting out the shells of driving brasses 1¼ ins. above the center of the axle, when its diameter is 9 ins., and others in proportion. For the location of the oil grooves at the sides they recommended cutting them 1 5/16 ins. above the top of the clearance or $2\frac{5}{16}$ ins. above the center of a 9-in. axle. This would locate the grooves a little below points 45 degrees from the top of the bearing. It is desirable to place the grooves in zones of light pressure and yet get them high enough to prevent the oil from passing down past the journal altogether, which would occur if the grooves are too near the lower edges of the bearings. This mistake of placing them too low has been made in several cases and, when raised, satisfactory results were given at once. This change was recently made on five heavy consolidation engines which were giving a great deal of trouble, and the heating seems to be entirely overcome.

It will be seen on referring to Fig. 4 that but one groove for side oiling is used on passenger engines on the Lake Shore and this is at the rear of the journal. For this service a simple groove will probably answer, because the engines very seldom, if ever, run backward. The groove at the front of the journal probably does no harm in forward running, but it may be expected to waste oil and carry it directly to the cellar.

Closely associated with the location of the oil grooves is the matter of cutting away the bearing surfaces of the brasses at the sides near the center of the axle, where no weight can be carried. This part of the brass does not serve any useful purpose. Its presence tends to scrape the oil from the journal and to cause the bearing to grip the journal when heated. It is not needed even when the brakes are applied.

The accompanying engravings illustrate several arrangements of the oiling grooves and clearances. A cast steel driving box for 8 by 9-in. journals is shown in Fig. 1, and a cast iron box for 9 by 12-in. journals in Fig. 2, both of these being by the Schenectady Locomotive Works. Fig. 3 is an 8½ by 12-in. driving box of the Lake Shore & Michigan Southern. Fig. 4 is the brass for that design, and Fig. 5 illustrates a driving brass of the Chicago Great Western with side oiling but no clearances.

Figs. 1 and 3 show two different ideas as to the shape of the clearances at the lower edges of the brass. In Fig. 1 these are straight, vertical cuts, extending ¾ in. above the center of the journal, while in Fig. 3 the clearances are radial and extend 1½ ins. above the center. The radial form of Fig. 3 was preferred on the Lake Shore to the straight clearance, because it gives a cavity of uniform width between the brass and the journal. When the clearance is cut with vertical sides it produces a cavity which is wider on top than at the bottom. We do not know whether waste and dirt have actually collected in the straight cut clearances, but the radial cutting was done to avoid cavities which grow larger above the bottom of the brass with a view of guarding against such a possible difficulty.

In the Schenectady bearings the oiling is all done through the side grooves, which are located 3¾ ins. from the top of the 8-in. and 4¼ in. in the 9-in. journal, these distances being measured along the arc of the bearing surface. These grooves extend across the brass and terminate about ⅞ in. from the edges. There is no opening at the top of the brass; what may at first to appear to be an oil hole here is a ¾-in. brass pin

through the top of the box and bearing. The oil grooves are ½ by ½ in. in section, milled out of the brass.

Figs. 3 and 4 show an entirely different plan and one which we believe is still considered experimental, although it appears to work well. It is the form used on the Lake Shore & Michigan Southern Railway. This brass has radial clearances 1½ ins. high at the rear side of the bearing; ⅝ in. above the edge of the clearance is a single ½ in. groove. There is in this case a cavity ⅞ by ¾ in. at the top of the brass, and this is filled with a number of asbestos boards saturated with oil and graphite, laid on edge and driven tightly into place. Oil is fed

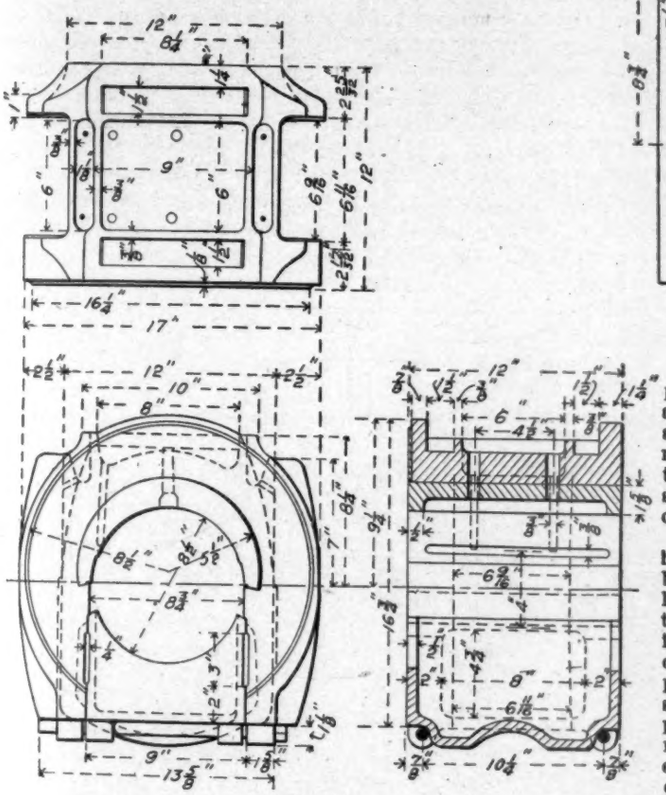


Fig. 3.

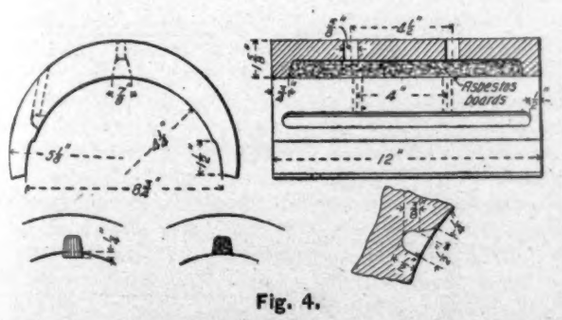


Fig. 4.

to this asbestos board through two ⅝-in. holes drilled through the box and brass, and opening into a large oil cavity in the top of the box. The sectional view of the oil groove at the side of the brass shows its form. It is ½ by ½ in. in section and the upper edge is chamfered off to increase the width of the groove to ¾ in. This width of groove and the chamfered edge seem to be effective in preventing the collection of dirt. It is possible that such a device may avoid this difficulty in every case. Probably those who have had trouble in keeping the side grooves free have made them too small. Such an application of asbestos board in a heavily loaded bearing is interesting. The idea seems to be to get oil to the journal without sacrificing bearing area, but from the experiments quoted in our October number it is a question which way the oil will

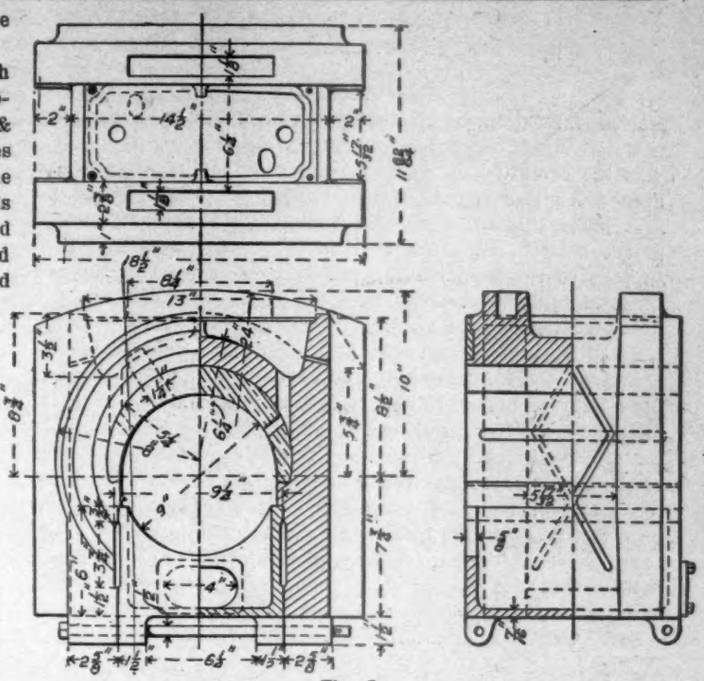


Fig. 5.

pass through the asbestos, up or down, if it passes through at all after running some time. The experiment is interesting and it may throw new light upon the subject. If the asbestos remains porous it will offer a very important advantage in retaining sufficient oil to run a long distance in case the oil supply upon the top of the box should run short. The large cavity, however, must necessarily weaken the shell.

In spite of all that may be done to lubricate driving boxes heating may occur if the side pressures of the hubs against the boxes are excessive. It is customary to use brass or babbitt liners on the boxes on driving wheel hubs, but the best practice, even when these liners are used, seems to consist in allowing considerable play of the journals in the boxes. On at least one road all trouble of this character has been overcome by providing ⅜-in. end motion of the journals or 3/16 in. on each side. As locomotives increase in weight and in height more play is needed, and if not provided when the engine is new the necessary amount of lateral motion will be obtained by the engine itself in the form of wear. It may not all appear at the driving wheel hubs, for some of the freedom may be gained by sharpening flanges. It seems evident that in common practice too little motion is allowed and that this has an important, even if indirect, effect upon the question of lubrication.

BALDWIN LOCOMOTIVES FOR FRANCE.

Forty locomotives for the Paris, Lyons and Mediterranean Railroad of France have been completed by the Baldwin Locomotive Works, and are to be loaded as soon as the steamer "Fortuna," now on her way, to this country, arrives at Port Richmond. This order was obtained by the Baldwin shops in competition with British builders, a sample engine having proved satisfactory to the authorities of the road. This is ground for congratulation because of the success of the Vauclain compound in competition with the noted four-cylinder compounds of the French railways.

A NEW RECORD ON THE LEHIGH VALLEY.

The Lehigh Valley Atlantic-type locomotive No. 670, pulling the Black Diamond Express, recently made a new record for this country in passenger runs. The train was eastbound, and 13 minutes late on leaving Rochester Junction. An attempt to make up this time between Rochester Junction and Manchester, a distance of 20 1/10 miles, resulted in a speed of 90 miles an hour for part of that run. On one section of the road, a distance of 5 1/10 miles was made in exactly 3 minutes and 41 seconds. For the last 1,800 ft. of that distance brakes were applied, slowing down for a train-order board. The first 4¾ miles, by actual blue-print measurement, was run in 3 minutes and 8 seconds. This speed was timed by three watches. The total distance was covered at an average rate of 88 miles an hour, and the rate for the first 4¾ miles was exactly 90 miles.

CENTER PLATES.

By Edward Grafstrom,

Mechanical Engineer Atchison, Topeka & Santa Fe Railway.

In the evolution of car design no detail of importance has been given less attention than the center plate. From the first plain sheet-iron plate with which the contact surface of the bolsters once was covered to prevent wear and give support to the king bolt, to the grooved, cupped or flanged types of to-day, there has been no transitory stage, but the increased train speed and freight-car capacity has demanded the abolishment of cast iron and made more reliable metals a necessity. The contour of the center plates seems to have been left to chance, or to the pattern-maker's or draughtsman's taste. Not until quite recently, since pressed steel center plates came into use, was it found advisable on some of the more progressive roads to define the contours, in order to avoid crushing or distortion under the heavy loads of the present day. The purpose sought was to obtain designs that could be reproduced in dies without injuring the metal, and little or no heed was given to what would otherwise be the most advantageous contour.

Such was the situation when the M. C. B. Association

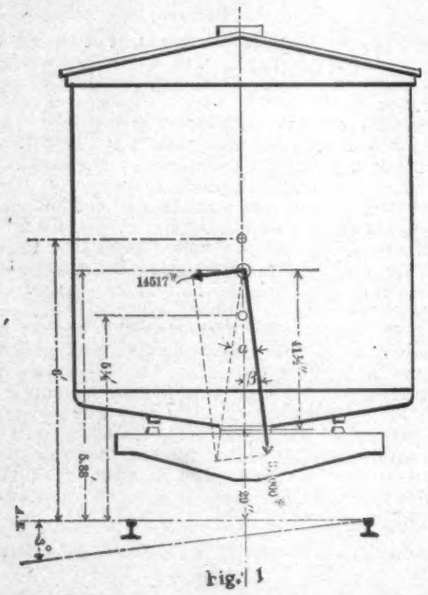


Fig. 1

charged a committee with the investigation of the subject last year. The report of this committee at the last convention shows a variety of opinions prevailing among car-builders, and the prejudices which will have to be overcome before any decisive action can be taken by the association on the subject. Further than this, the report contains suggestions as to the stiffness, dimensions and shape of center plates. Considering these suggestions in order, the first one being dependent on and subordinate to the others, can be disposed of here with the remark that the report covers the ground fully. As far as the dimensions of the center plates are concerned, however, the report is open to dispute.

Without stating the reasons for doing so, the committee assumes that a pressure of 400 lbs. to the square inch of bearing surface should be the rule for determining the dimensions of center plates. If the committee aimed to avoid the crushing of the metal, it need only be said that ten times the amount stated should not have been feared. If it was intended to avoid excessive wear, the committee's own observations, that the movement of the center plates on an 18 degree curve was imperceptible, seem to make this precaution unnecessary. The same applies to heating. Friction did not form a basis for determining the pressure per square inch, for the report gives as an excuse for the generous bearing surface recommended that "the friction is as the weight to the number of inches on which it is distributed," which is supposed to mean that the friction is independent of the areas in contact, notwithstanding that in case of a large center bearing the friction has a greater leverage than with a smaller one.

The suggestion of this committee to establish 400 lbs. per square inch as a general rule for center plates appears most striking if taken in connection with the report of the com-

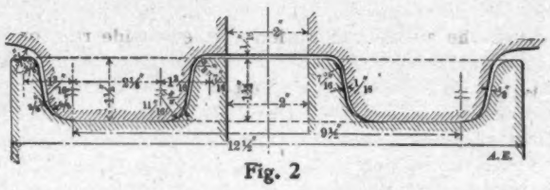


Fig. 2

mittee on side bearings, following immediately upon it, in which the opinion was expressed that 800 lbs. per square inch is considered proper. It should also be noted that that committee used a center plate with 1,405 lbs. pressure per square inch with very fair results. These differences would naturally lead one to think that within reasonable limits the pressure has nothing to do with the size of the center plate, or, in other words, a center plate good enough for a 60,000-lb. car will also answer for a 100,000-lb. car, providing that its thickness is sufficient to sustain the weight without bending or breaking. The convenience of having an interchangeable center plate for all equipment is indisputable. What, then, should the size of such a center plate be?

The tests which the committee on side bearings made show conclusively the advantage of carrying the load on the center plates with a clearance between the side bearings. If the center plates are sufficiently large for the resultant of the weight and the centrifugal force on curves to fall within the contact surfaces, all reasonable demands ought to be met. Though the momentum of the car may cause it to tilt over on the side bearing momentarily when entering a sharp curve, it would regain its equilibrium on the center plate at once. The first question is, therefore, to determine the angular deflection of the line of strain resulting from the combined forces which act on a car on a curve.

The accompanying diagram, Fig. 1, shows the position of a box car on a curve. The reason for selecting a box car is that its center of gravity is located higher and its centrifugal force on a curve is more in proportion to its weight than in other classes of freight cars. The speed of the car is assumed not to exceed 50 miles per hour; for such a speed a minimum curvature of 1,000 ft. is generally conceded to be good main-line practice. The outside rail is assumed to be elevated to

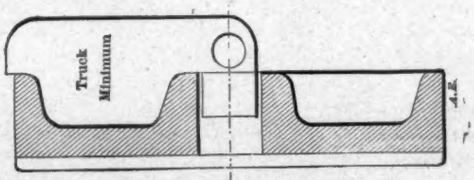


Fig. 3

an angle of 3 degrees, which is also believed to be in accordance with good practice. The center of gravity of the ordinary box car body, empty, has experimentally been found to be located about 5½ ft. above the rail, and the center of gravity of the lading to be about 6 ft. The car body is assumed to weigh 21,000 lbs., and the lading is taken at 66,000 lbs. This makes a total weight of 87,000 lbs., with a resultant center of gravity located at a height of 5.88 ft.

An 80,000-lb. box car might have been selected instead, but,

as the principal difference of construction lies in the size of the floor sills, and in the deeper floor trussing, and as these cars are generally longer in order to carry the increased tonnage, the center of gravity will be found to come lower. The same applies to an 80,000-lb. gondola car, and also to a 100,000-lb. hopper car on which the load carried in the hopper below the floor lowers the center of gravity somewhat. For these reasons it is believed that a 60,000-lb. box car will give a fair average value for the purpose of this calculation.

For a speed of 50 miles per hour the centrifugal force of the car under consideration will be found to be 14,517 lbs. From the equation $87{,}000 \operatorname{tg} a = 14{,}517$, a will be found to be 9 deg. 30 min. Subtracting from this the angle β, which is equal to the angle of elevation of the outside rail, or 3 deg., there remains 6 deg. 30 min. The contact surfaces of the center plates are generally about 29 ins. above the rail; subtracting this from 5.88 ft. leaves 41½ ins. from the common center of gravity to the contact surfaces. This multiplied by the tangent for 6 deg. 30 min. gives the deviation of the line of pressure from the center line of the car in the plane of the center plates' contact surfaces, and will be found to be 4¾ ins. Twice that amount, or 9½ ins., will therefore be the necessary diameter of the contact surfaces of the center plates, under the conditions named.

The writer has designed a set of center plates based upon these calculations, illustrated in Fig. 2. The diameter of the

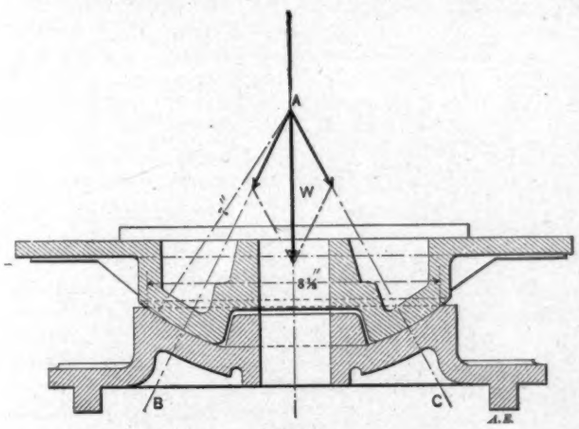


Fig. 4

bearing surfaces is 9½ ins., and the outside width is 12½ ins. The actual bearing surface of each is 50 sq. ins., and the approximate static pressure is 870 lbs. per square inch. The guiding surfaces are made sloping sufficiently to enable these center plates to be reproduced either as castings or in pressed steel. The concave fillets in the truck center plate are of a larger radius than the corresponding corners of the body center plate, the object being that if the car body is jolted to one side, the body center plate will commence to climb up on the fillet in the truck center plate, whereby the side thrust will be expended before the guiding surfaces of the center plates come together with the force of a blow, on the same principle as the fillet of a wheel flange is made of a larger radius than a corner of the rail head. The clearance between the center plates is only 1/16 in. at the hub, while it is ⅛ in. at the rim, and the guiding is therefore done at the hub, where the friction has the shortest leverage. Center plates of this pattern and of these dimensions have been introduced to some extent on three important railroads under cars of from 60,000 to 80,000 lbs. capacity, as well as under heavy tenders, the total number in use so far being approximately 4,000 cars and tenders.

In order to insure a good fit a set of templets or gauges has been devised for ascertaining the maximum or minimum dimensions permissible, a variation of 1/32 in. from the normal contour, or a total variation of 1/16 in. being allowed the manufacturers. With the clearance mentioned this variation is not sufficient to cause a body center plate of the maximum size to bind with a truck center plate of a minimum size. The use of these gauges is shown in Fig. 3.

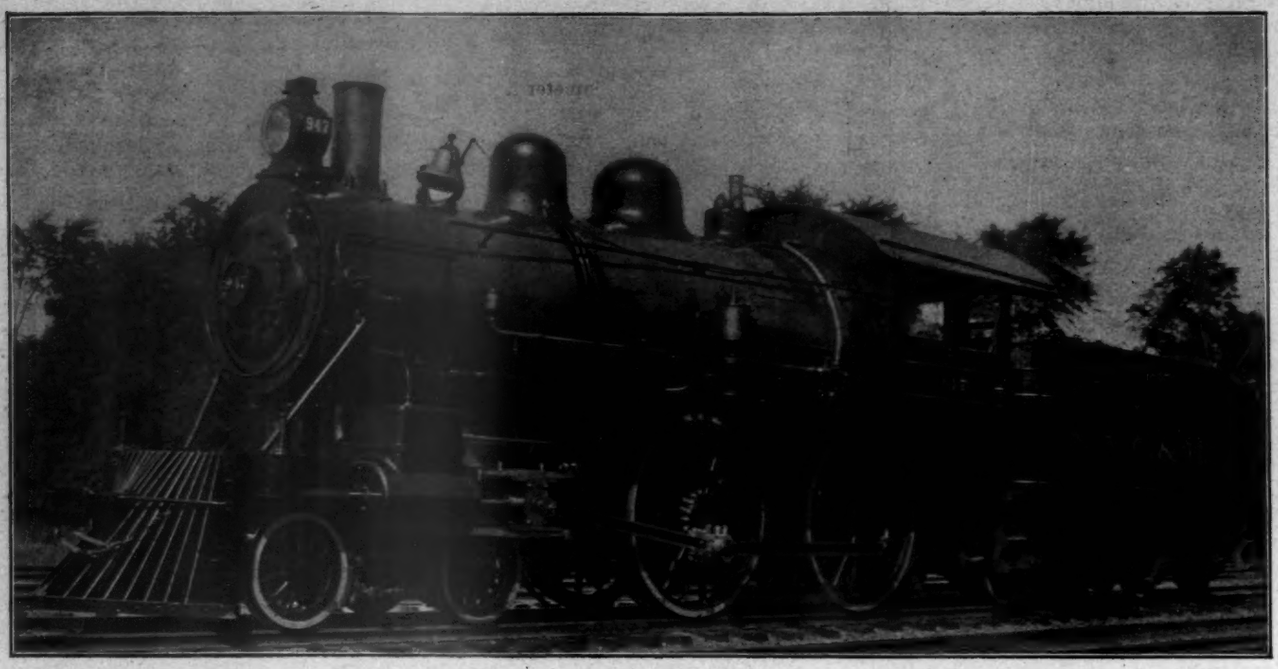
Considering, finally, the cup or ball shape center plate, there is no need of adding anything to the committee's condemnation of this form. Attention should be called to the fact, however, that with this style of center plate the friction increases as the radius of the bearing surface decreases, if the outside diameter of the latter remains the same, just as a tapering plug valve turns with more difficulty the less taper it has. To further illustrate this, take the center plate shown in Fig. 4, which in form and dimensions represents a common type in use on thousands of cars. By applying the principle of the parallelogram of forces, the weight, W, on the center plate may be divided into a number of components distributed in the conical plane, A, B, C, the sum of all of which will be found to be 12 per cent. more than W itself, and as the friction is proportionate to the pressure, it follows that the resistance to curving is 12 per cent. greater with a center plate of the form and dimensions shown than with a flat center plate of the same outside diameter.

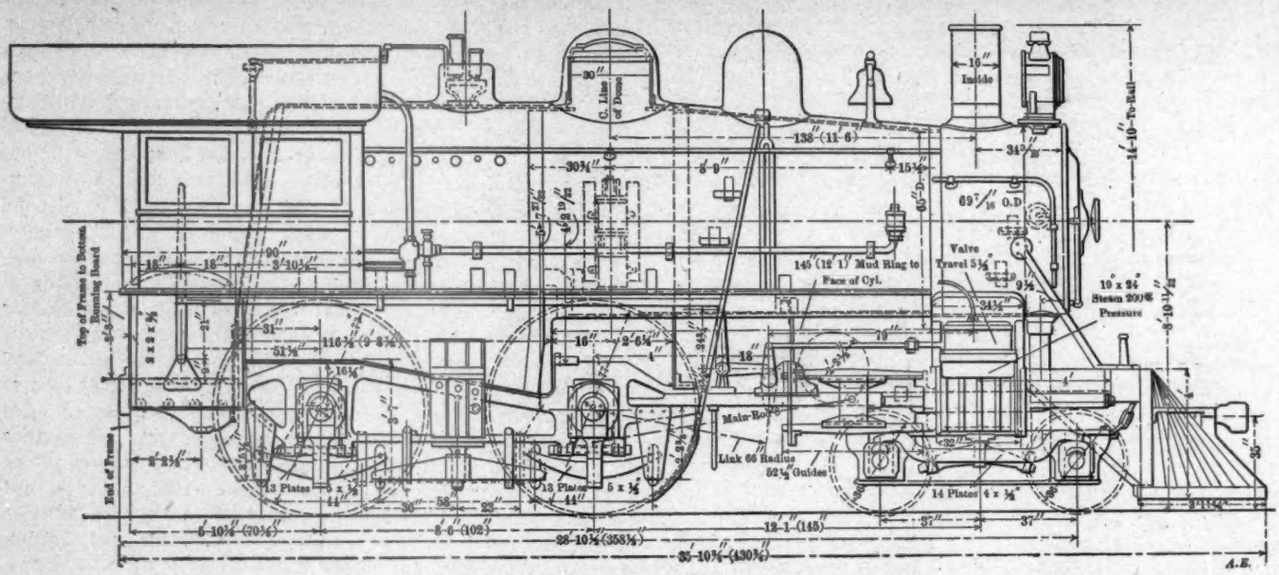
A LOCOMOTIVE MUSEUM.

The trustees of Purdue University recognize the fact that certain classes of locomotives which have long done service on American roads are now giving way to newer and heavier machines. In the natural order of events the old will be converted into scrap, and unless an effort is made to preserve them, designs which have been familiar to past generations will completely disappear. The occasion calls for a collection of typical machines and it is believed that it is not inappropriate that Purdue should take the initiative in forming one. In accomplishing its purpose, the University must necessarily depend upon the co-operation of railway companies. It asks, therefore, that roads having engines which for any reason are distinctive, consider the advisability of preserving a sample at Purdue. It is not expected that engines will be offered so long as they are useful to the roads owning them, but only that as engines are put out of service, one be sent to Purdue, instead of being scrapped. It is not asked that any transfer of ownership be made. The University is prepared to agree to meet transfer charges, to house and to otherwise care for engines thus deposited, and to hold the same at all times subject to the order of the owner. The fact should be noted that it is not the purpose of the University to collect engines for the purpose of securing numbers. The engine to be desirable must be distinctively different from others of the collection.

Three engines have already been secured. One of these is to come as a gift from a Western road, which for the present desires its name to be unknown. It is of the 8-wheeled American type, as built thirty years ago. It represents the class of engine which first performed the transcontinental service of our country. The second engine is to come through the courtesy of the Baltimore & Ohio Railway and represents the "camel-back" type, which has so long been in service upon that road. The third is the English engine "James Tolman," which was exhibited at the World's Fair in 1893, and which has since been in the keeping of the Chicago, Milwaukee & St. Paul Railway. There is needed of the old class of engines one of the single-driver type and one having inside cylinders; also, types of switching engines. As time goes on a representative of the higher class of mogul and consolidation will doubtless be obtainable.

For the accommodation of such engines as have already been assured, a rough shed will be provided; but in time it is hoped that a suitable engineering museum building will be provided which will serve as a place of deposit for the very large amount of museum material which is now either the property of Purdue or has been intrusted to its keeping.





EMPIRE STATE EXPRESS LOCOMOTIVE.

NEW YORK CENTRAL & HUDSON RIVER R. R. MR. A. M. WAITT, *Superintendent of Motive Power and Rolling Stock.*

NEW "EMPIRE STATE EXPRESS" LOCOMOTIVE.

New York Central & Hudson River Railroad.

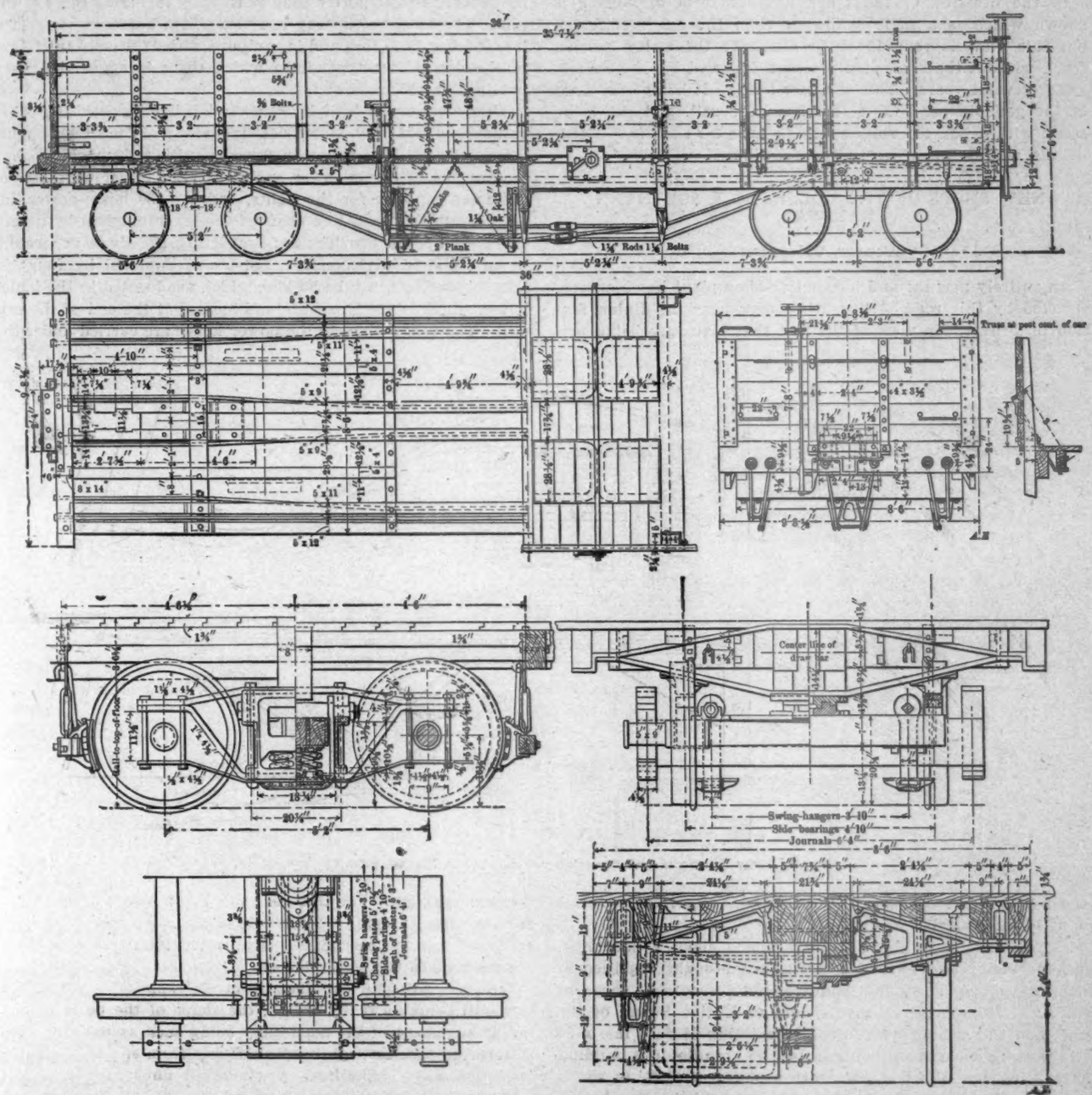
This engine is described with a feeling that in a sense it is the last of its race. It is difficult to realize the progress of locomotive design until, in glancing over recent notable engines, one is struck with the passing of the 8-wheel type. The appreciation of boiler power has led to a reluctant discarding of this type for the hardest passenger service, but the type still occupies an important place in other service, and if very fast, light trains were as common in this country as in England and France, the 8-wheel engine would undoubtedly remain the favorite. The tendency, however, in this country is toward heavier trains.

Mr. A. M. Waitt, of the New York Central, recently designed and built the handsome engine of this type which is illustrated in the accompanying engraving. It is an improvement upon the similar designs which have been widely known as representing Mr. Buchanan's idea of a passenger engine, and which have hauled the Empire State Express for a number of years. It was found necessary to strengthen the frames and enlarge the boilers, and this led to an entirely new engine, with the same sized cylinders and driving wheels as before. The boiler is 65 ins. in diameter, it has a sloping back head and radial staying, the heating surface being 2,404 sq. ft., which, with the exception of the passenger engines of the Chicago & Northwestern (described on page 224 of our July issue, 1899), is the largest for 8 wheels of which we have record. The Northwestern engine has 2,507 sq. ft. The heating surface of the earlier engines was 1,900 sq. ft. The grate area of the new one is 30.7 sq. ft., which is the same as before. The total weight of the engine is 146,400 lbs., and that on drivers 94,400 lbs. The tender weighs 108,000 lbs. Only one of these engines has been built, but there is another under way. For this particular train the service given has been very satisfactory, but it hardly need be said that this is an indication that this famous train is not difficult to handle. The boiler, cylinders, frames and tender were built at the Schenectady Locomotive Works, the work having been completed at the Depew Shops of the road. Mr. Waitt changed from the four-bar to the alligator cross-head and improved the engine in many ways, but without making radical changes.

LOW DROP-BOTTOM GONDOLA CAR, 80,000 LBS. CAPACITY.

Chicago & Northwestern Railway.

This new car is interesting because of the trussing, the depth of the body bolsters, the use of three needle beams, the stiffening of the siding, and, chiefly, because the design has been approved for adoption on the Chicago & Northwestern; the Chicago, St. Paul, Minneapolis & Omaha; the Fremont, Elkhorn & Missouri Valley, and the Sioux City and Pacific lines, all of which are allied with the Chicago & Northwestern. The drawings have been received through the courtesy of Mr. C. A. Schroyer, Superintendent of the Car Department of the last-mentioned road:



Low Drop-Bottom Gondola Cars, 80,000 Pounds Capacity.

CHICAGO & NORTHWESTERN RAILWAY. MR. C. A. SCHROYER, *Superintendent Car Department.*

Chief Dimensions of the Cars.

Length over end sills	36 ft. 0 ins.
Width over side sills	8 ft. 6 ins.
Length inside of box	35 ft. 7½ ins.
Width inside box	9 ft. 4 ins.
Height, rail to top of sides	7 ft. 6¾ ins.
Height of siding	4 ft. ⅛ in.
Cubical capacity	1,365 cu. ft.

The drop doors, eight in number, close flush with the lower faces of the side sills. They are hinged to the three needle beams as shown in the side elevation and section. Mr. Schroyer has obtained unusual depths of trussing of the car body and also of the body bolsters. The lower bearings of the truss rods are 33 ins. below the upper faces of the side sills and four of the six truss rods support all of the needle beams. The trussing is clearly shown in the side view and transverse section. The needle beams are 4½ by 12 ins. in section. The side sills are 5 by 12 ins.; the outside intermediates and the center sills, 5 by 9 ins., and there are also two 4 by 5-in. sills at each end of the car between the end sills and the outer needle beams. The queen posts at the center of the car are braced by a 2-in. plank shown in the side and end views.

The body bolsters are 15⅛ ins. deep. The top plate is ⅞ by 8 ins., with 4-in. shoulders at the ends, and the lower plate is 1⅛ by 8 ins. The bolster plates are held apart by a large casting, and there is also a filling casting between the bolster

filling blocks. The center sills are reinforced at the draft rigging by ⅜ by 7-in. plates 4 ft. 6 ins. long.

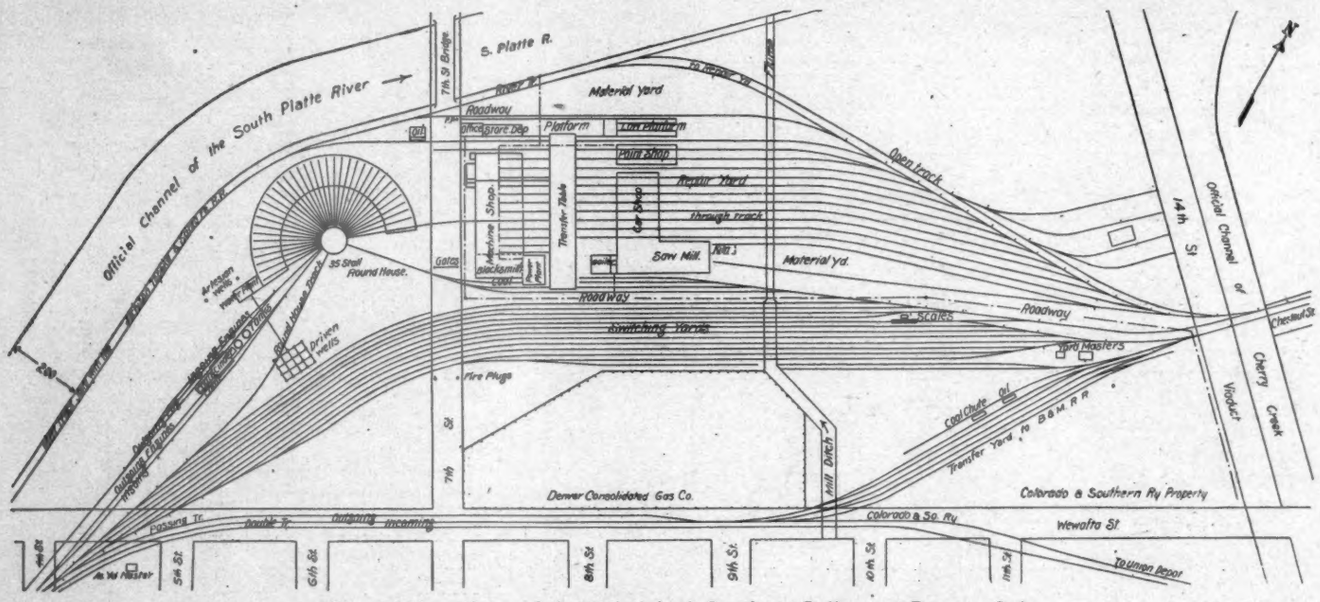
In addition to the drop doors the car has two side doors at diagonally opposite corners, one of which is shown in the side view. All of the longitudinal sills are of long-leaf yellow pine, the end sills, needle beams, buffer blocks and stakes are of white oak, and the siding of Norway pine. The bracing of the side stakes is shown in one of the detail views.

In the drawing of the truck another form of bolster is shown which is a little shallower than the one mentioned, but this view is reproduced to illustrate the swing motion truck without the sand plank, a plan followed by Mr. Schroyer for several years. This is a low truck. It brings the floor of the gondola car 3 ft. 6 ins. from the rail, and the same truck with a box car makes this distance 3 ft. 5¾ ins. Other details will be apparent in the drawings.

NEW SHOPS OF THE COLORADO & SOUTHERN RAILWAY.

Denver, Colorado.

An entirely new car and locomotive-shop plant has been constructed by this road at Seventh Street, near the Union Station in Denver. In view of the fact that plans are being prepared on several roads for new shops, a description of this plant is particularly timely.



Plan of New Shops of the Colorado & Southern Railway at Denver, Colo.

The distance from the Union Station is about a half mile, and the shops and switching yards are brought together in the same plot. The office building containing the offices of Mr. A. L. Humphrey, Superintendent of Motive Power of the road, and the Master Mechanic, is a building 38 ft. 5 ins. x 64 ft., the store department being housed in an adjoining building 32 ft. 3 ins. by 101 ft. in size, with a platform 48 ft. in width and extending about 225 ft. beyond the end of the storehouse, where it terminates with an incline leading into two low platforms, 16 ft. wide by 150 ft. long. The transfer table, which is 70 ft. wide and 400 ft. long, extends the full length of the machine and car shops and reaches to the storehouse platform.

The machine shop has a transverse track arrangement and is 125 ft. by 323 ft. 5 ins. in size. At the south end the blacksmith shop occupies a length of 57 ft., and adjoining the blacksmith shop is the power house. A 50-ton, 65-ft. traveling crane will be erected in the locomotive shop. There are 12 tracks with concrete pits in the erecting shop, and opposite each track is a door sliding vertically.

Between the transfer table and the locomotive shop is a space 70 ft. in width, while on the other side the distance from the table to the car shop is 110 ft., sufficient for handling the truck work on Pullman cars.

The machine shop is equipped throughout with new tools and plentifully supplied with pneumatic hoists. The tool room, which is an annex beside the machine shop, has received careful attention from Mr. Humphrey. The boiler work is done in a portion of the locomotive shop 60 ft. long, including three of the pits. The blacksmith shop has two steam hammers, one 4,000 lbs. and one 1,500 lbs., and is equipped with 18 Sturtevant forges of the down-draft type, from which there is no smoke given out into the shop.

The power house is 60 by 80 ft. and it has three Allis-Corliss engines, of 125, 150 and 250 horse-power. The large engine drives two 85-kw. dynamos for the mill and machine shop motors, the 125 horse-power engine drives another generator of the same capacity for the lights, and the 150 horse-power engine drives the main line shaft of the machine shop by a belt. The switchboard provides for connecting the three generators in any desired arrangement. Steam is supplied by four 150 horse-power return-tube boilers, which are located in the boiler house, which is 110 ft. square and located at the end of the saw mill. The steam pipes to the power house are carried under the transfer table pit. The transfer table has a speed of 175 ft. per minute when carrying a 240,000-lb. engine. A capacity of 1,200 cu. ft. of free air per minute is provided for in two Rand air compressors in the power house.

The saw mill and car shop form an L-shape building, the saw mill being 50 ft. by 244 ft., the shape of the building and the arrangement of the machinery being such as to permit the material to pass through it continuously from end to end without unnecessary handling. A somewhat unusual plan is followed by placing the car-wheel machinery, wheel press and nut-tapping machines on one side of this building in order to get it out of the machine shop and locate it near the car work. In the mill the power is distributed entirely by motors. The mill has a cement floor.

The car shop, containing eight tracks, is 110 ft. by 178 ft., and beyond it is a two-track paint shop, 48 by 161 ft. This building has two stories, the upper one providing for the varnish room and the cleaning of light work. The ground plan also illustrates the locations of the material yard, repair yard, dry kiln, oil house, the round house of 35 stalls, the coal chute, cinder pit and water service. Water, except for boilers, is obtained from 20 driven wells, in which the water rises to within

7 ft. of the surface of the ground. It is raised by two 1,000-gal. pumps in a small building adjoining the round house. The tanks shown on the plan each have a capacity of 50,000 gals. The water from the driven wells is used for washing out boilers and for the lavatories, which are, by the way, unusually complete, while the water for boiler use comes from two artesian wells near the pump house, which are sunk to a depth of 700 ft. From these the water is raised to the second tank by an air lift. The arrangement of the tracks leading to the round house is indicated clearly in the engraving.

The plans and construction were carried out by Mr. H. W. Cowan, Chief Engineer, with the co-operation of Mr. A. L. Humphrey, Superintendent of Motive Power. Special care has been taken with the lighting of the buildings, which is seen in the fact that the pits in the erecting shop are all fitted for lamp connections to avoid the use of torches. The other details of lighting are equally complete. This is mentioned, however, because it is unusual.

The entire work of construction has been accomplished since last July.

A BROAD VIEW OF LOCOMOTIVE DESIGN.

Building for the Future.

An Address by W. H. Marshall.

Because of his thorough appreciation of the necessity for considering the needs of the future in view of the rapid advances in the requirements of locomotives, and his well-balanced ideas concerning the subject in general, an address delivered recently by Mr. W. H. Marshall, Superintendent of Motive Power of the Lake Shore & Michigan Southern Railroad, before the students of Purdue University, is an exceedingly important contribution at this time. We regret that we cannot reproduce it in full, but shall, however, attempt to indicate its most important points.

After briefly mentioning the advance in the capacity of locomotives during the past ten years, Mr. Marshall considers the question of design as influenced by the demand for increasing the proportion of revenue freight to the total load hauled, than which in all the field of railroad expenditures no greater possibilities of saving exist. This is the direction in which the largest economies are to be effected, and it explains the remarkable increase in the size of locomotives. If motive power officials perform their full portion of this work they will accomplish more in the reduction of expenses for the companies they serve than can be achieved through shop practices and routine work of their departments, important as these are.

When large freight power is wanted, the first question is, how heavy shall the engine be? The author of the paper is positive upon this point, and says: "If the finances will permit it, the spirit of conservatism should not prevent the transition by a single step to the most powerful engine the road can use. Unless the physical condition of the road establishes other limits, I would say as a general proposition that the road should not only build the largest engines that can be used advantageously to-day, but, if possible, should meet the conditions that will prevail in the future, say five or ten years from to-day."

He directs attention to the fact that the length of trains being limited, the lighter capacity cars will disappear in the time mentioned, and trains will be composed of 30, 40 and 50-ton cars, which will require an engine weighing, say, 170,000 lbs. on the drivers. The tendency to improve the loading of freight cars is an additional reason for building heavy engines. Considering the life of a locomotive as 20 years, we ought not to build merely for to-day, but for years in advance.

The next important item is the selection of the type. After determining the number of driving wheels required, the question of the truck remains. Mr. Marshall is satisfied with the safety of the two-wheel leading truck, and the question of design, then, rests upon whether the limit of weight is that upon the driving wheels or the total weight of the engine. Where weight on drivers is limited, and not the total weight of the engine, the four-wheel truck permits of increasing the boiler capacity. It is stated as a general proposition that a four-wheel leading truck should not be used in any modern design of heavy freight engines unless it is employed to increase the boiler capacity through additional weight which can not be placed upon the driving wheels.

The question of speed of fast freight trains next receives attention. The author believes that speeds of 25 and 30 miles an hour can be handled better with a large engine than with a small one, provided proper care is taken in the matter of details of construction. For moderate grades he considers 62 or 63 ins. a satisfactory diameter of the driving wheels, and reports excellent service with wheels of this diameter under consolidation engines of the Lake Shore road, which have now been running more than a year. While the larger wheels require large cylinders and additional strength in the frames and running gear, and on this account involve additional weight, a substantial gain is had from the fact that the motion of the machinery is slower for a given speed, which saves in maintenance and reduces engine failures. He considers the advantages to lie greatly in favor of the large wheel.

It is noted that the eight-wheel type is unable to meet the demands of the heaviest fast passenger service. More wheels are required, and the question is: "After the eight-wheel engine, what next?" In his answer to this question Mr. Marshall makes what appears to us to be a most important and thoughtful suggestion, which is commended to the consideration of those who are now working out designs for new passenger locomotives. Far sightedness in this connection is needed. While giving a high place to the recent Atlantic-type designs, Mr. Marshall believes that ultimately the limited amount of weight of this type for tractive purposes will lead to the adoption of some other type of engine for the heaviest of passenger service. For this work three pairs of drivers are needed. The question is often asked why so much tractive weight is necessary when it can be utilized to the utmost only in getting away from stations, the mean pressure of the pistons being too small at high speeds to utilize greater tractive weight. Mr. Marshall reasons that without it engines can not start trains of from 12 to 15 cars without taking slack, and to back one of these heavy engines against a passenger train until all the draft springs are compressed and then reverse it suddenly, allowing it to surge ahead, is not only destructive to the couplers throughout the train, but is very unpleasant to passengers. Furthermore, after the train is in motion the weight on two pairs of drivers is not sufficient to utilize the full cylinder power from the first quarter of a mile from the station if the rail is slippery. These two conditions occasionally involve serious loss of time, which must be made up.

The ten-wheel design would be preferred if it were possible to get a wide grate over driving wheels of, say, more than 72 ins. in diameter, but Mr. Marshall is thoroughly convinced of the importance of six coupled wheels combined with the wide grate, and with large driving wheels would prefer an arrangement of wheels similar to that of the Prairie type of the Burlington.

While there are many other important parts of the address which we would like to comment upon, the ones already mentioned seem to be most vital, and others will be referred to later.

The selection of Saratoga as the location of the next conventions of the Master Mechanics' and Master Car Builders' Associations will please all concerned, because, all things considered, it is the most satisfactory meeting-place. This year the order of the conventions is to be reversed, and the Master Mechanics' Association is to hold its sessions first. They will begin on Wednesday, and the Master Car Builders on the following Monday, with Sunday between the two conventions. At the executive committee meeting at which these details were arranged the committee on draft gear was authorized to spend $1,500 in securing information for its report, and a valuable presentation of the subject is thus assured. There can hardly be a more important topic before the association this year than that of draft gear.

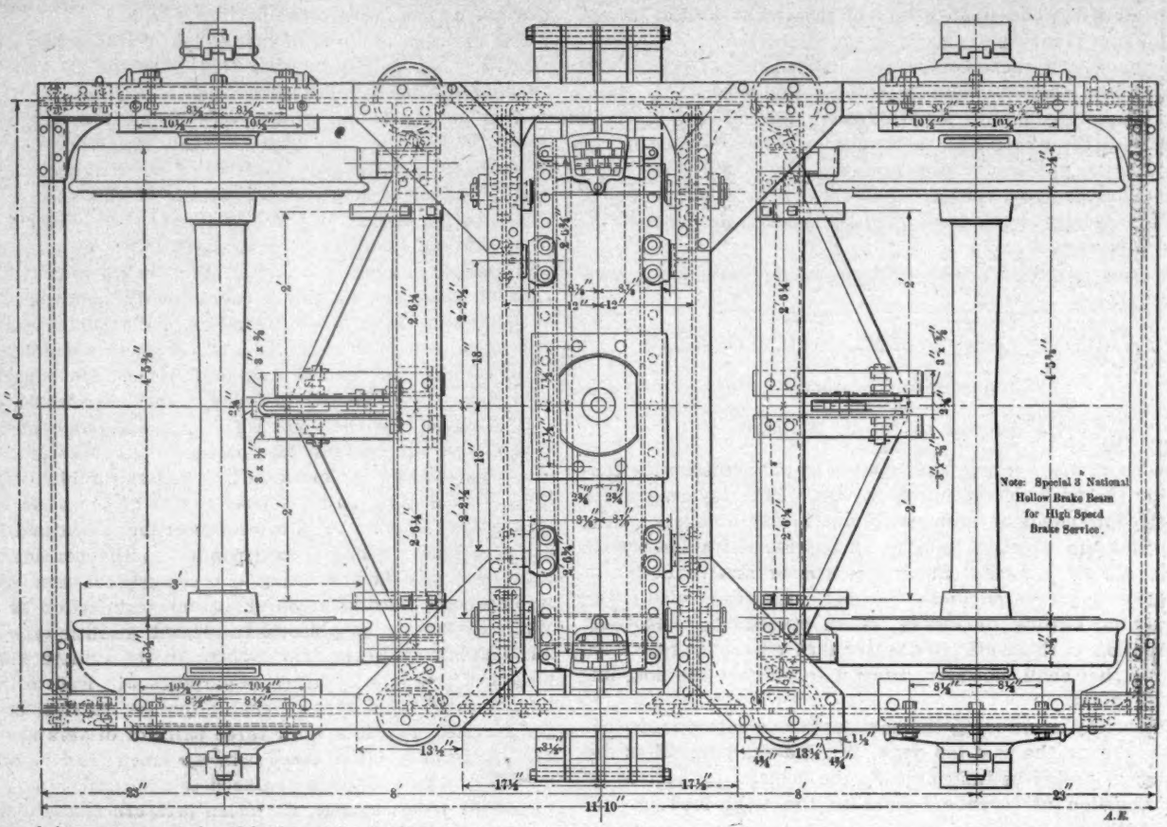
FOUR-WHEEL STEEL FRAME TRUCK AND STEEL FRAME DRAFT GEAR

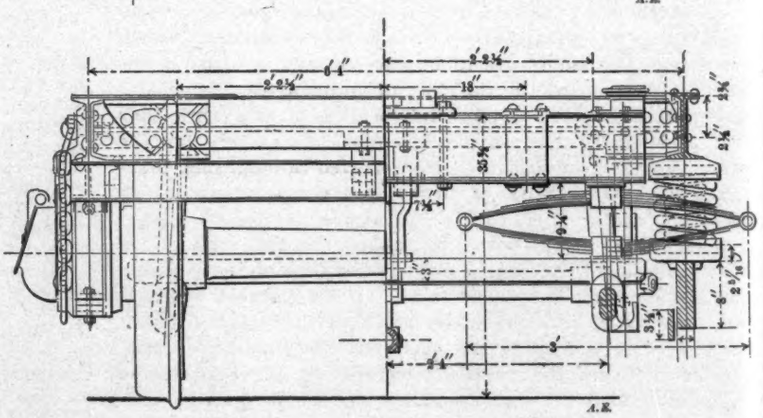
For Passenger Equipment. Lake Shore & Michigan Southern Railway.

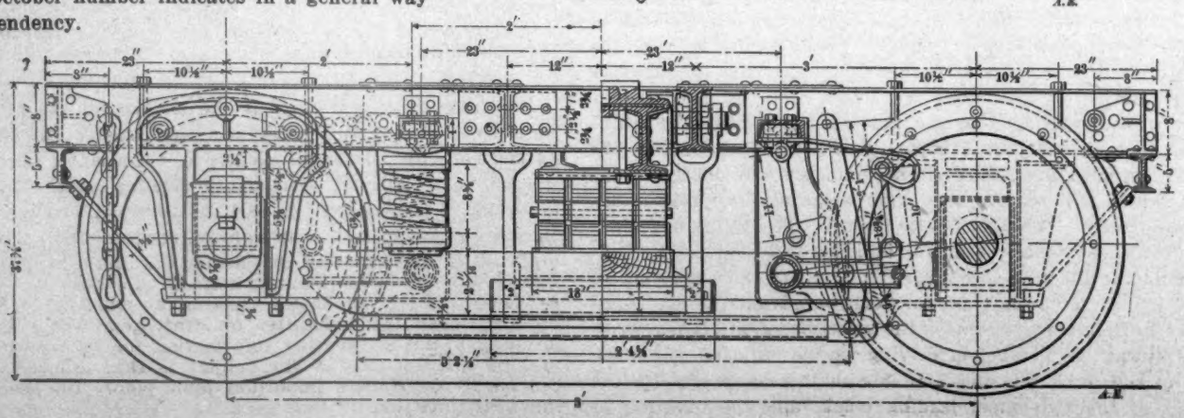
Passenger trucks for heavy cars have received considerable attention of late and several designs have been prepared with a view of improvement in this important element in car design. There is an evident desire to get down to a four-wheel truck and to this without sacrifice of safety, the 5 by 9 in. axle is employed. There has been no attempt, so far as we know, by any railroad in this country to make any change in the general plan of spring and equalizer suspension, the usual construction in this respect being followed. Saving in weight and first cost of trucks is desired and this is accomplished by a reduction in the number of parts, such as frame stiffeners, wheels, axles, boxes and bearings. The four-wheel truck recently designed and constructed for the Illinois Central and illustrated on page 306 of our October number indicates in a general way the tendency.

In the accompanying engraving, made from drawings received through the courtesy of Mr. H. F. Ball, Mechanical Engineer of the Lake Shore & Michigan Southern, this idea has been developed further and steel frame construction used in place of wood. This design is in a degree experimental, but it seems to be well carried out and is promising of still further development.

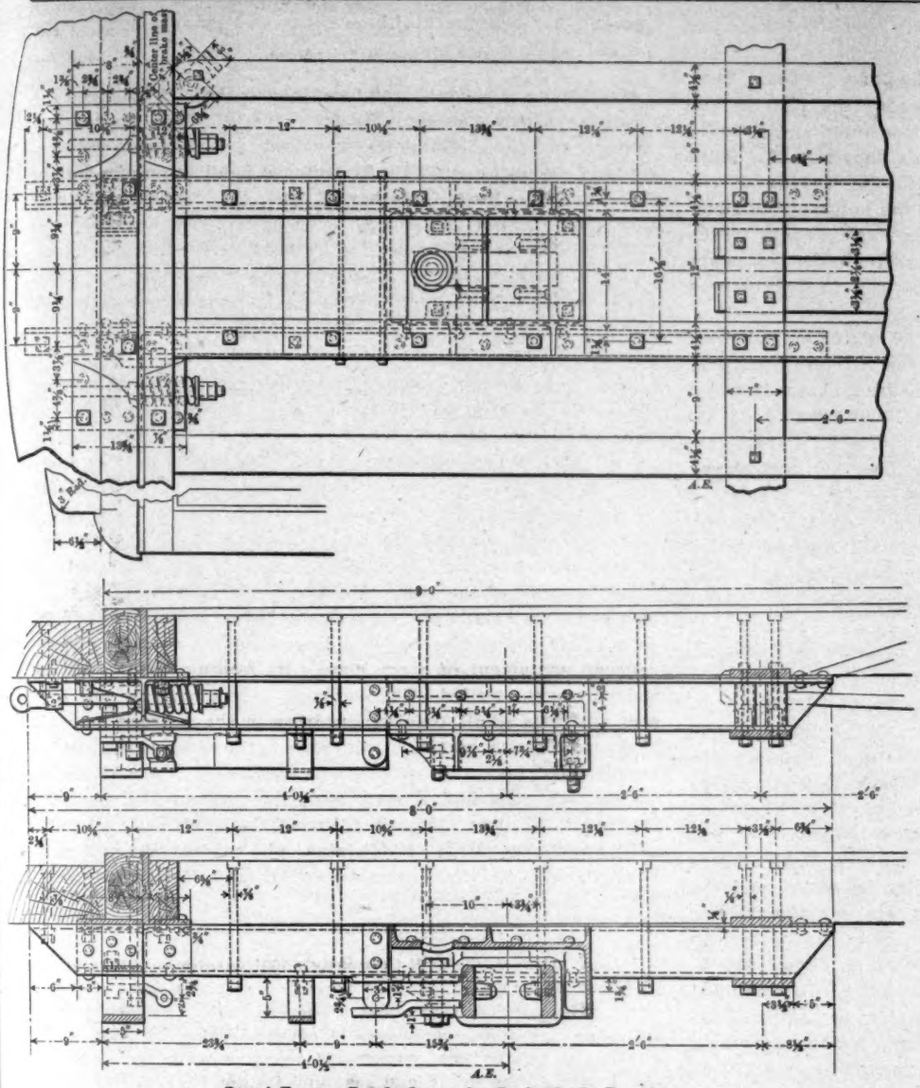
The first consideration was to secure a stiff frame which







Four-Wheel Steel Frame Truck, Lake Shore & Michigan Southern Ry.—Plan Side Elevation and Section.

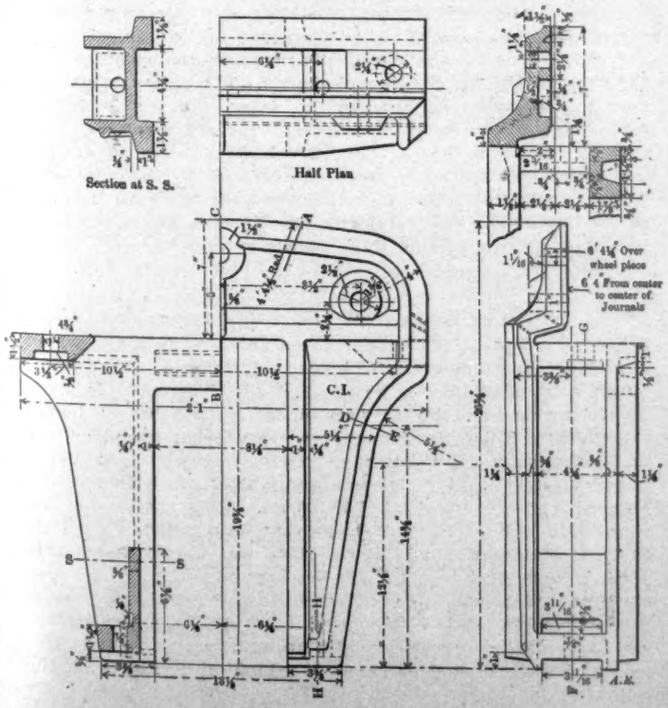


Steel Frame Draft Gear, L. S. & M. S. Railway.
Plan and Longitudinal Sections.

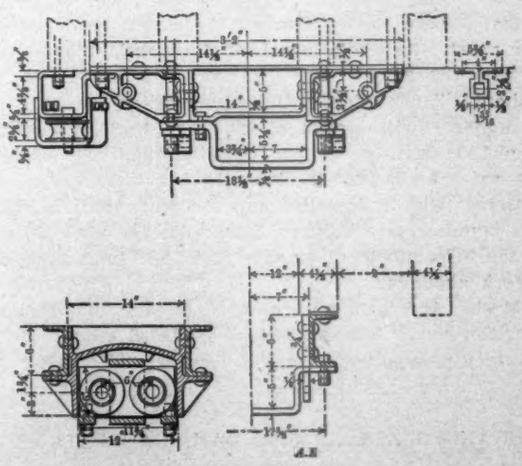
led to the selection of 8-in. I-beams for the side members. It was also desired to use as few different sections as possible and this led to the selection of the same section for the transoms and truck bolsters. The truck bolster has cover plates, making it a box girder, and this selection of sections happens to give about the same fiber stress in all the most important members. A maximum fiber stress of about 8,000 lbs. per square inch was aimed at throughout the truck. The frame has additional stiffening from two 6-in. channels, from which the brake hangers are suspended.

The swinging links were made as long as possible, about 24 ins., and the upper attachment is made by a fork embracing neatly fitted malleable iron bearing castings secured to the transoms by substantial rivets. These castings have a good bearing over against the I-beams and they also give long bearings for the pins, which, it will be noticed, pass through the I-beam at its neutral axis. These bearing castings also form the connecting pieces between the transoms and side frames. The end members are 5-in. I-beams. They are dropped below the side frames in order to give sufficient clearance for the draft attachments and are secured to the side frames by carefully designed corner castings.

Throughout the truck the rivet holes were placed as near as possible to the neutral axes of the steel members in order to



Details of Pedestal.



Details of Draft Gear.

avoid cutting away material which might be needed for strength. The equalizers are 8 ins. deep by 2¼ ins. wide, the object being to avoid deflection. Cars sometimes ride roughly on account of the deflection of the ends of the equalizers, which has a tendency to cause the journal boxes to tilt in the pedestals and bind in such a way as to prevent the free action of the boxes from the springs. These trucks have a wheel base of 8 ft. and this involves a long brake rod, which in this design is made of 2½-in. "double extra strong" wrought iron pipe. The length of this rod is 5 ft. 2⅜ ins. be-

tween centers and the ends are welded in. The pedestals are of the usual form, except as to their upper parts, which are shaped to make secure joints with the side frames. They have a full bearing on the lower faces of the frames, and are slipped into place from the side of the frame and securely bolted from the outside, their form being shown in the detail drawing. Attention should be called to the bracing of the frame, this and the methods of securing the joints of the members being clearly indicated in the engravings. These trucks were designed for use under postal cars. The brake beams are the special 3-in. National hollow type for the high-speed brake.

We also show drawings of a new steel platform and draft gear for passenger equipment on this road. This draft gear has only three essential parts—two 6-in. draft channels and a steel casting secured between them. It is illustrated as applied to postal cars. At the outer ends of the draft arms substantial cast steel brackets are fitted. These are best shown in the end view and elevation. By means of these castings, in which the safety chain draft rods and springs are attached, the pulling stresses from the safety chains will still be carried by the draft beams in the event of the breaking or parting of the couplers.

HIGH-SPEED SUBURBAN SERVICE BY WATER.

An interesting development of high-speed marine suburban service for New York City is promised for next summer. Mr. A. S. Guerber, a wealthy resident of Nyack-on-Hudson, has placed with Mr. Charles D. Mosher, the naval architect, an order for three fast twin-screw passenger steamers to run from New York to Nyack, stopping at Yonkers, Dobb's Ferry and Tarrytown. The distance is 30 miles by water, and the boats, with a speed of 35 miles an hour, are to make the trip in an hour, including all stops. According to the "American Shipbuilder" the boats will be of steel throughout, 150 ft. long, 15 ft. beam and 4½ ft. draught. The hulls will be divided into seven water-tight compartments, and each boat will accommodate 250 passengers. They will have a women's saloon 30 ft. long by 14 ft. wide, and a broad companionway will lead to the women's boudoir on the deck below. The men's saloon will be 55 ft. long by 14 ft. wide, and below it will be the smoking room. Above the saloons will be a promenade deck, extending nearly the whole length of the vessels, where the life boats will be swung. The lighting will be by electricity throughout. The models will be graceful, with sharp bows. The machinery will consist of twin quadruple-expansion engines of 4,000 horse-power and complete auxiliary machinery. In this way a high-speed marine suburban service of considerable interest will be installed and the plan appears likely to become popular, especially to those who are now obliged to brave the discomforts of smoky, dark, hot tunnels in which New York abounds.

Mr. Mosher is known by a number of successful high-speed boats: "Norwood," "Ellide," which made 35 knots; the "Arrow," which is expected to make 40 miles, and others.

CHANGES AMONG THE RAILROAD PAPERS.

Mr. Willard A. Smith, who has owned and conducted the "Railway and Engineering Review" for many years, and has been closely identified with technical railroad newspaper work, has decided to resign from the management of the Cloud Steel Truck Company and return to the direct management of that publication. While for several years his attention has been directed in other lines, including an important commission in the Chicago World's Fair, the Paris Exposition and the supply of railroad equipment, he has retained his interest in journalism and we welcome his return to active management of the journal which represents his life work.

Mr. Bruce V. Crandall, who has for several years managed the "Railway and Engineering Review," the "Railway Master Mechanic" and the "Official Railway List," of Chicago, has severed his connection with the first-named publication and bought the "Railway Master Mechanic" and the "Official Railway List." Mr. Walter D. Crosman, who has so ably conducted the "Railway Master Mechanic," will continue in editorial charge, and his marked ability, combined with Mr. Crandall's attributes as a business man, assure an increased success to the publications.

The "Railroad Car Journal," in its December issue, announces that with the next issue it will change its name and character and merge into a new publication, entitled "Railroad Equipment," with a new policy and field. The "Railroad Car Journal" was established in 1891 and has been devoted exclusively to the car departments of railroads. Its field was becoming too small, and the editorial announcement states that its exclusive character had become prejudicial to its standing and value because of the transition which has placed the car departments in a subordinate position under motive power officers. This led to the decision to enlarge its field to include railroad equipment of every class. Its leading feature will be a department entitled "The Railroad Digest," which will present abstracts of all articles appearing in the railroad journals of the world, with particular reference to the construction, maintenance and operation of railroad equipment. Mr. Albert G. Glover, who has had a wide newspaper experience, and Mr. Edward A. Phillips, formerly editor of the "Railroad Car Journal," assisted by Mr. G. S. Hodgins, will conduct the new publication, and we wish them and "Railroad Equipment" success in the new enterprise.

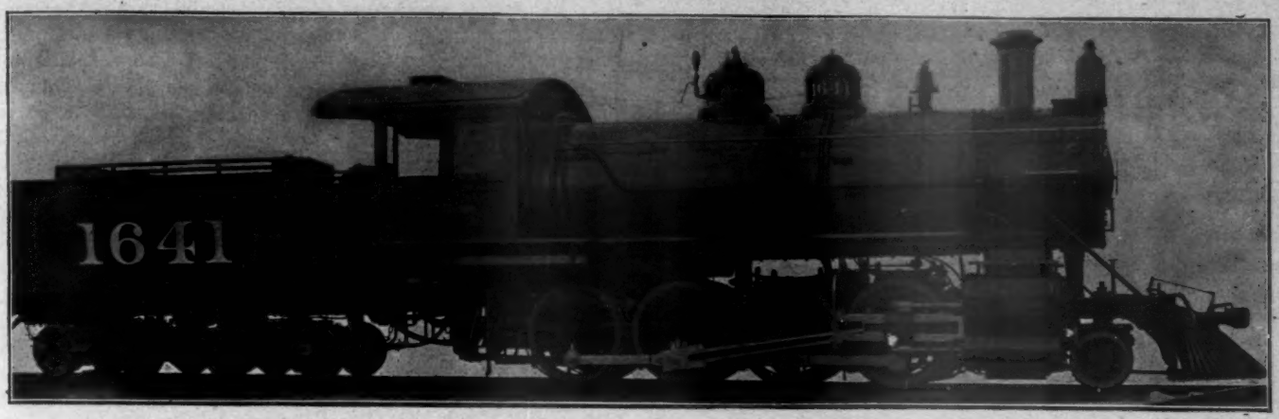
A copy of the J. G. Brill Company's 1901 catalogue, illustrating and describing their patented round-corner seat-end panel for open cars, has been received. The pamphlet, besides giving full-page half-tone engravings of several styles of open cars, shows line engravings, reproduced from working drawings, of the details of the round-end seat and its application. By making car seats with a round end the objection to the ordinary seat panel and the cross-seat open car in general is largely removed. Many advantages are given for this new idea of round-end seat, one of which is the ease of entering the car. Instead of the sharp projecting corners, the openings from the sides of the car are funnel-shaped. The safety to passengers is increased, the car has the same capacity as the old style, and in stormy weather dryer seats will result from the ease of operating the curtains, which drop to the floor. The car makes quicker time on account of the greater ease with which people may enter and leave, and the appearance of the car is improved. The catalogue also gives a list of the more important railways using these panels on open cars.

"The Pittsburgh Special"—a new train, No. 24—was established Nov. 25th on the Pennsylvania Lines. This train, which is now running daily from Chicago to Pittsburgh, is for Pittsburgh passengers from Chicago and the West, and is made up of drawing-room, buffet, sleeping car and coaches. It leaves the Chicago Union Station at 8.00 every evening and arrives in Pittsburgh at 8.30 the next morning. Lunch or light supper is served after leaving Chicago, and a light breakfast may be enjoyed before arrival at Pittsburgh. This special has no connection east of Pittsburgh, so that only tickets from Chicago to Pittsburgh and intermediate stations at which this train is scheduled to stop will be honored on it. The Pennsylvania Lines have also increased their through car service between Toledo and Washington, D. C., by a new sleeping-car line. The new service offers an opportunity to leave Toledo at 5.08 P. M. and arrive in Washington at 1.00 P. M. the following day.

VAUCLAIN COMPOUND CONSOLIDATION LOCOMOTIVES.

Union Pacific Railway.

Deliveries on a large order of 60 Vauclain compound consolidation locomotives for the Union Pacific Railway have begun by the Baldwin Locomotive Works, one of the engines being illustrated in the accompanying engraving. These engines are powerful, but



CONSOLIDATION COMPOUND LOCOMOTIVE, UNION PACIFIC RAILWAY.

J. H. MCCONNELL, *Superintendent Motive Power.* BALDWIN LOCOMOTIVE WORKS, *Builders.*

Cylinders:	15½ and 26x30 in.	Boiler pressure	200 lbs.
Wheel: Driving	57 in.; engine truck 30 in.;	tender wheels	33 in.
Weights: Total of engine	185,320 lbs.; on drivers 161,020 lbs.;	total engine and tender	305,000 lbs.
Grate area and tubes: Grate area	33.8 sq. ft.	Tubes	321 2 in.; 13 ft. 6 in. long.
Firebox: Length	120 in.; width 40 in.;	depth, front 74 in.;	back 71 in.
Boiler: type, straight,	radial staying.	Diameter	72 in.
Heating surface: Tubes	2,255 sq. ft.; firebox 194.9 sq. ft.;	arch tubes 25.6 sq. ft.;	total 2,475.5 sq. ft.
Wheel base: Driving	15 ft. 3 ins.; total of engine 23 ft. 11 ins.;	engine and tender	53 ft. 5¾ in.
Tender: Eight-wheel;		water capacity 6,000 gals.	

their chief interest centers in their being the first compounds to be used on this road. In various ways the design indicates the ideas of the builders, and it was probably considered best to leave the builders as far as possible unhampered as to details, in order to secure a perfectly fair demonstration of the abilities of the compound. The boiler has an extended smokebox, but a short one, with only room enough for the cinder spout, in front of the saddle. These engines are to be used on various portions of the road, and on account of their power, as well as the compounding, they will probably prove a great relief in the handling of the present heavy traffic. These engines are designed for a maximum curvature of 10 degs. All of the driving wheels are flanged.

This road is also receiving a lot of 10 very heavy compound passenger locomotives of the 10-wheel type, which we shall illustrate in a future issue.

The principal dimensions of the freight engines are given in the following table, for which, as well as the photograph, we are indebted to the builders:

Baldwin Consolidation Freight Compounds.
Union Pacific Railway.

Cylinders, diameter, high-pressure	15½ ins.
Cylinders, diameter, low-pressure	26 ins.
Cylinders, stroke	30 ins.
Cylinders, valve	Balanced piston
Boiler, diameter	72 ins.
Boiler, thickness of sheets	11/16 in. and ¾ in.
Boiler, working pressure	200 lbs.
Boiler, fuel	Soft coal
Firebox, material	Steel
Firebox, length	120 3/16 ins.
Firebox, width	40⅝ ins.
Firebox, depth	Front, 74¼ ins.; back, 71¼ ins.
Firebox, thickness of sheets	Sides 5/16 in., back 5/16 in., crown ⅜ in., tube ½ in.
Tubes, number	321
Tubes, diameter	2 ins.
Tubes, length	13 ft. 6 ins.
Heating surface, firebox	194.9 sq. ft.
Heating surface, tubes	2,255 sq. ft.
Heating surface, fire-brick tubes	2,425.6 sq. ft.
Heating surface, total	2,475.5 sq. ft.
Grate area	33.8 sq. ft.
Driving wheels, diameter outside	57 ins.
Driving wheels, diameter of center	50 ins.
Driving wheels, journals	9 x 10 ins.
Engine truck wheels, diameter	30 ins.
Engine truck wheels, journals	6 x 10 ins.
Wheel base, driving	15 ft. 3 ins.
Wheel base, rigid	15 ft. 3 ins.
Wheel base, total engine	23 ft. 11 ins.
Wheel base, total engine and tender	53 ft. 5¾ ins.
Weight on drivers	161,020 lbs.
Weight on truck	24,300 lbs.
Weight, total engine	185,320 lbs.
Weight, total engine and tender	305,000 lbs.
Tender, diameter of wheels	33 ins.
Tender, journals	5 x 9 ins.
Tender, tank capacity	6,000 gals.

A bill for the adoption of the metric system by the United States Government has been favorably reported to Congress by the committee on coinage, weights and measures. It provides for the adoption of the metric units January 1, 1903, for use by all the government departments except in the completion of the surveys of public lands. Russia has recently officially adopted the system, and if the bill is enacted, England will remain the only important civilized nation yet to take such action.

UNITED STATES MAIL SERVICE.

The annual report of Second Assistant Postmaster-General Shallenberger shows that during the year ending June 30, 1900, the expenditures for the inland transportation of mails was $55,146,059, and for foreign mails service $2,014,537, a total of $57,160,597. The Star routes numbered 22,834, of an aggregate length of 260,857 miles, and the service cost $5,133,378. The railroad routes numbered 2,668, of a length of 179,982 miles, and cost $33,424,982. The most expensive service was the pneumatic tube service, which cost $222,226 for five routes of 8 miles in length, or nearly $30,000 per mile. At the close of the year there were 1,268 lines of traveling post-offices (railroad, steamboat, electric and cable cars), covering 178,960 miles in length; the number of clerks employed was 8,974; annual miles travelled by them in crews, 200,672,785; adding to this the closed pouch and express pouch services, the grand total of miles travelled was 305,436,095. The number of whole cars and apartments in use and in reserve was 3,658. In addition to these there were 25 cars on electric and cable lines and 72 apartments on steamboat lines. It is estimated that there were handled by railway postal clerks during the year 7,363,191,360 pieces of first-class matter and 6,429,415,800 of all other classes of matter, making a total of 13,792,607,160 pieces. In addition to this there were handled by railway postal clerks 18,128,063 packages and cases of registered matter, 1,100,423 through registered packages, and 621,712 inner registered sacks, in all 19,850,198. During the year there were 1,355,464 errors reported as made by clerks in the distribution of this mail, the ratio being one error to 10,175 correct.

(Established 1832

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE,
J. S. BONSALL, Business Manager.
MORSE BUILDING.....NEW YORK

G. M. BASFORD, Editor.
E. E. SILK, Associate Editor.

JANUARY, 1901.

Subscription.—$2.00 *a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union. Remit by Express Money Order, Draft or Post Office Order. Subscriptions for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn St., Chicago, Ill. Damrell & Upham, 283 Washington St., Boston, Mass. Philip Roeder, 307 North Fourth St., St. Louis, Mo. R. S. Davis & Co., 346 Fifth Ave., Pittsburg, Pa.*

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 20th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* When a subscriber changes his address *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: Chicago, *Post Office News Co., 217 Dearborn Street.* London, Eng., *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

In his article in this issue Mr. W. S. Morris, of the Chesapeake & Ohio, adds a strong statement to the facts which tend to place the large capacity steel car in the foremost rank of railroad improvements. He speaks in no uncertain tone of the influence of this movement and, being known as a careful man, his testimony will have weight with those who are still in doubt. Where the traffic is suitable for these cars they will pay handsomely. Where 80 or 90 miles per day may be had from them on an average in regular service they will pay for themselves in a few years. We are specially interested in his comparisons of earnings per train mile for steel and wooden cars at $11 and $6.59, a difference of $4.41 in favor of steel cars, for the same train expense in both cases. He says that the cost of transportation in handling 40 steel cars containing 2,000 tons of freight would be the same as 1,500 tons loaded in 60,000-lb. capacity wooden cars. He also offers striking figures when he shows that 1,000 loads carried in 100,000-lb. and 60,000-lb. cars would mean 25 trains for the steel cars and 31 trains for wooden ones, a saving of six trains and 729 tons of dead weight. This shows in a graphic way the reason why the large steel cars have made such remarkable progress in three years.

The selection of type or wheel arrangement for locomotives for fast and heavy passenger service involves most interesting questions, promising important developments in the near future. It is relatively easy to haul fast and light trains, but fast and heavy ones furnish the problem and require great tractive power as well as sustained boiler capacity. For a large proportion of present passenger traffic the able Atlantic type engines, which we have illustrated recently, suffice, but it is a question whether it is not advisable to use the same number of wheels and couple six of them instead of four where starting power is now or is likely to become in the immediate future an important consideration. Mr. Marshall's idea, commented upon elsewhere in this issue, seems to us to be timely, viz., to build for the future and use six coupled wheels for heavy passenger engines. This is specially applicable to roads where double-heading is practiced, and in general it may be stated that for heavy work three pairs of drivers are necessary. If this is granted, the 10-wheel engine is the first arrangement to suggest itself, and then the wide firebox comes up for consideration. In our October number, of last year, page 312, Mr. Gaines, Mechanical Engineer of the Lehigh Valley, presents a design for 10-wheel engines soon to be built for that road which seems likely to exert an important influence upon future practice, because it combines a wide firebox with 72-in. wheels, but Mr. Gaines goes still further in this direction and believes that there is no objection to using the same arrangement with 84-in. drivers, for either soft or hard coal. The engines referred to were illustrated in outline in the article mentioned, and while they have not yet been built, there is no reasonable doubt of their performance. Those who consider it necessary to provide ample depth as well as width in fireboxes will look askance at the wide grate over the large wheels, but it may prove that there is enough to be gained from the wide grate and the arrangement of six coupled wheels and a four-wheel truck to overbalance a possible loss due to the lack of depth. We shall give our readers further information about the Lehigh Valley engines when they are built and running.

Next in importance to the improvement of draft gear among the subjects to come before the Master Car Builders' Association this year is that of center plates and side bearings, and the latter subject merits careful attention, because of the wide difference of opinions expressed by two committees last year. In this issue Mr. Grafstrom indicates the possibility of applying thoughtful study to the design of center plates, and what is more, he presents a design which is giving satisfactory service under 4,000 cars and tenders. His suggestions are worked out carefully and put into the form of practice, and in cars of large as well as small capacity. He even includes gauges for measuring the amount of allowable variation in the contour, and has, in short, applied to this subject the attention which it deserves and has not, to our knowledge, before received. Others are thinking about it, however, and rather radical suggestions have been made, one of which is in the direction of using center plates of very large diameters, even as large as 24 ins., with a view of making them serve to a degree to take some of the work ordinarily expected of the side bearings. This whole question is in such a state as to open the way for a logical and practicable method of carrying the weights of cars to the trucks so as to avoid friction of turning and permit the trucks to become square with the tracks after coming out of a curve. The work before the committee this year is therefore most important, and there is an opportunity to settle some of the disputed points in which side bearings, center plates and bolsters have a part. The difficulties lie not so much with large capacity steel cars as with the vastly larger proportion of equipment of smaller capacity in the form of wooden cars, and as this forms the greater number of cars in use, it is a question in which all are interested, and one which has to do with the entire end structure of cars. It is not by any means an easy problem.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Forty-second Annual Meeting.

The first session of the forty-second meeting of the American Society of Mechanical Engineers was opened Tuesday evening, December 4th, at the society rooms, 12 West Thirty-first street, New York, with an unusually large attendance. The annual address, "Some Landmarks in the History of Rolling Mills," was delivered by President C. H. Morgan, who presented in a very comprehensive manner the growth of the industry of rolling mills and its influence on the railroads and civilization. The early part of the second session was taken up with the business of the society and the annual election of officers. The election resulted as follows: President, Samuel T. Wellman, of Cleveland, O.; Vice-Presidents, Arthur M. Waitt of New York, James M. Dodge of Philadelphia and Ambrose Swasey of Cleveland; Treasurer, William H. Wiley, New York; Secretary, F. R. Hutton, New York.

On Thursday the fourth session was held at Havemeyer Hall of Columbia University, upon special invitation from President Low. After the reading of papers in the morning the society was the guest of the university for the remainder of the day.

The first paper presented at this meeting was "Comparison of Rules for Calculating the Strength of Steam Boilers," by Mr. H. De B. Parsons. Both the paper and the discussion which followed showed clearly the differences in the several rules now used in determining the strength of the different parts of a steam boiler. The sentiment was that the United States Government rules are faulty and that it is better to use the foreign rules, or those of the American insurance companies. A motion was passed to the effect that the council consider the appointment of a committee to look into the matter of adopting uniform rules.

Mr. Charles T. Porter, in his paper, "A Record of the Early Period of High-Speed Engineering," traced the early history of the high-speed engine by an interesting account of the life of the late John F. Allen, who had to do directly with the development of the high-speed engine, and bringing into practice the steam engine indicator.

"The Steam Engine of Maximum Simplicity and Highest Thermal Efficiency," a paper by Dr. R. H. Thurston, was a history of the development of the steam turbine, giving definite facts as to the efficiency established by various tests, and was discussed from the standpoint of cost, exacting work required to build steam turbines and their application to marine propulsion.

Mr. Wm. Sangster, in his paper, "Note on Centrifugal Fans for Cupolas and Forges," lays much stress on the importance of the method of applying fans to widely differing installations, and as to establishing a fixed rule covering the ground for all installations, it would be impossible. The paper offers several formulas for computing the power required by centrifugal fans in cupola and forge practice, treating separately cupola fans, forge fans and smoke exhausters. The relation of outlet pressure to outlet area of fans was also considered.

Considerable discussion, both oral and written, followed the presentation of Mr. F. W. Dean's paper on "A Power Plant of the Massachusetts General Hospital." The paper, though criticised from the standpoint of certain features of the plant, was valuable in that it brought out from those present the experiences in up-to-date operations.

The next paper presented was on the "Construction of Contracts," by Mr. R. P. Bolton, and contained a copy of the "Uniform Contract," adopted and recommended by the Institute of Architects and National Association of Builders, which the author severely criticises and also suggests necessary conditions which should be included in this contract.

The concluding paper of the evening was that of Mr. E. T. Adams, "An American Central Valve Engine," which received a careful and somewhat limited discussion. The paper is a descriptive argument in favor of the principal characteristics of the central valve engine. The author tells what an engine of this type, designed for a wide field of service, should be. The engine must have moderate speed, must be of the vertical type, because it requires less floor space, single-acting, to comply with limited head room; it must have a central valve, because it allows ample port opening with very low clearance and affords practically perfect drainage of the cylinders, and it must be compound if the gain in economy shall justify the expense. The paper also gives a brief description of the valve gear.

As was previously announced, the Thursday morning session was held at Havemeyer Hall, Columbia University, and the first paper of the morning being a description of "A Mechanical Integrator Used in Connection with a Spring Dynamometer," by M. H. Wickhorst, designed by the author for use on the Chicago, Burlington & Quincy Railroad dynamometer car for the purpose of automatically and autographically showing the average drawbar pull. The mechanical integrator consists of a registering wheel, which slides backward and forward in sympathy with the dynamometer springs, and a circular disk, making in this case nearly three revolutions per mile, and on which the registering wheel slides. The registering wheel is a small steel wheel 2 ins. in diameter, and the disk is brass, 11 ins. in diameter. The wheel is so placed that when there is no compression of the springs it stands on the center of the disk. Its plane is at all times at right angles to the line of motion of the spring compression. Thus the farther the wheel gets from the center of the disk, the more revolutions will it make for a given number of revolutions of the disk. The sliding of the wheel back and forth on the disk causes no revolving of the wheel. Only the turning of the disk causes the wheel to revolve, and in proportion to the distance the wheel is from the center of the disk. The discussion on this paper was with regard to the interpretation of these records, which were not explained fully in the paper. Mr. R. H. Soule offered a ready means of reading such diagrams.

Mr. C. A. Read's paper presented "An Apparatus for Dynamically Testing Steam Engine Indicators" and brought out a discussion on the care of indicators, methods of allowing for errors after the errors were determined and the advisability of oiling the piston of an indicator.

The following paper, "A New Recording Air Pyrometer," by Mr. W. H. Bristol, was descriptive of an instrument invented by him for measuring temperatures of high ranges, and to give continuous records of changes of such temperatures on a moving chart. The paper was a most interesting one, as was evident from the liberal discussion which followed its presentation. The highest temperature at which the author has had experience with his instrument is about 2,200 degrees Fahrenheit, but he says he sees no reason why it should not be successful up to 3,000 degrees Fahrenheit.

Mr. F. M. Wheeler then read his paper, entitled, "Comparative Value of Different Arrangements of Suction Air Chambers on Pumps," in which he shows that an air chamber is just as necessary on the suction end of a pump as on the delivery end, if the noise and severe effect of water-hammer is to be avoided. He also insists on the importance of the proper location of the air chamber.

The opening paper of the final session was that of Prof. W F. M. Goss, on "Tests of the Boiler of the Purdue Locomotive." This was a valuable paper and is printed in abstract in another part of this issue.

The next paper was by Mr. W. B. Gregory on "Tests of Centrifugal Pumps," which gives by diagrams the results obtained from tests made on two centrifugal pumps, one with a 2½-in. suction pipe and a discharge pipe 2 ins. in diameter. The large pump had a discharge pipe of 25 ins. and two suction pipes, each 36 ins. in diameter.

Mr. W. J. Keep then presented a paper on the "Hardness or the Workability of Metals," in which he considers the development and results of a machine perfected by himself for

testing and recording by diagrams the workability of metal specimens. The author also gives results obtained from the machine.

This paper was followed by one on the important subject, "A New Principle of Gas Engine Design," by Mr. C. E. Sargent. The author gives an account of the development of a gas engine designed by himself to meet not only the requirements of prime movers, but to be simple and cheap in construction and easy of operation. The principal feature of the engine, besides having two tandem cylinders, is its interesting method of governing, which is different from that of the usual engine, in that the explosive mixture is not admitted the entire length of stroke, but cut off at a point somewhat less than half stroke and expanded for the remainder of the stroke. On the return, it is compressed from the point where cut-off took place. The discussion which followed the presentation of this paper was complimentary to the various features of the design of the engine, commenting particularly on the considerably reduced pressure and temperature of the exhaust.

Mr. C. V. Kerr's paper, "Heat Efficiency of a Gas Engine as Modified by the Point of Ignition," described tests made at the Armour Institute of Technology, on a Fairbanks-Morse gas engine. The discussion of this paper, as well as the following one, was limited to those presented in writing, which were not read, but handed over for publication in the transactions of the society.

"Power and Light for Machine Shop and Foundry" was the concluding paper of the meeting and was read in part and commented on by the author, Mr. F. R. Jones. This paper describes some extensive investigations recently made by the author on two power plants, with regard to electric power transmission and light. A large number and variety of tools were tested to determine the power required to drive these various machines. The paper gives in table form some of the derived data in this connection.

SOME CONVENIENT CAR SHOP DEVICES.

By Oscar Antz.

In almost every shop there can be found appliances for saving labor or for turning out better work which are not found elsewhere and are gotten up through the ingenuity of some of its employes, small things which may not appear to amount to much, but which, when shown to others, are often copied and made use of in place of more antiquated methods. The descriptions which follow are of appliances belonging to this class.

A double axle-lathe no doubt saves time over a single one in turning up an axle, but more time is usually consumed with it in placing and removing the axle; the appliance shown in Fig. 1 was designed to facilitate this part of the work and with it an axle can be put into a double lathe as quickly as in a single one.

Any style of lift can be used, ending at the bottom in a plain cylindrical rod with a nut, but an air hoist, suspended from a traveler on a track above the lathe is no doubt the most convenient.

The attachment consists of a frame of wrought iron, one end of which hangs from the bottom end of the rod of the hoist, and is free to turn about it, being supported by the nut and washer. At about the center of the frame is a hook from which hangs a pair of tongs, which are so arranged that when the weight of the axle is upon them they will remain tightly closed. The other end of the frame terminates in a fork which straddles the axle and holds it in place. Fig. 1 shows the arrangement clearly and needs no further explanation, the parts being so proportioned that the center of gravity, when the axle hangs suspended, is directly under the center of the hoist.

The track for the hoist is straight for part of the way over the center line of the lathe, one end curving out to the front to facilitate the entering of the axle through the driving collar and dog, and to pick up and deliver the axle away from the lathe. Where the dog is used on the right side of the driving mechanism, as is usually the case, it has been found that it is most convenient to enter the axle from the left and put on the dog after the axle is part way through the driving mechanism.

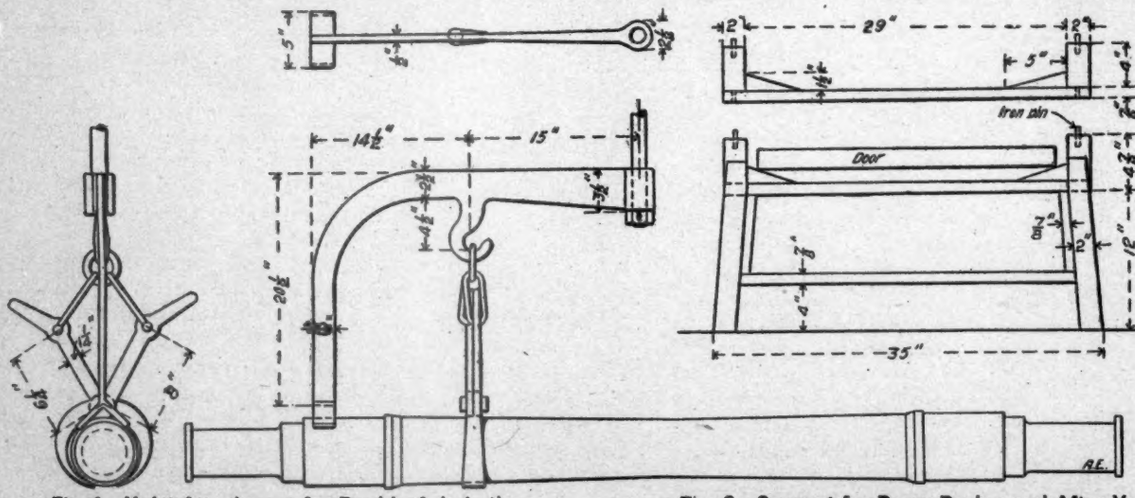


Fig. 1.—Hoist Attachment for Double Axle-Lathe.

While the heating of passenger cars by steam is compulsory in some States, stoves and hot-water heaters are still allowed and used in some parts of the country. The latter are preferred by many to stoves, as they distribute the heat more uniformly over the car. To prevent freezing when the fire in one of these heaters is accidentally or purposely put out, the water in the pipes is usually nearly saturated with salt, and it does not solidify until a very low temperature is reached. To make salt-water of the proper strength quickly and economically, the arrangement shown in Fig. 2 was devised. Three barrels with only the bottom heads are superimposed on one another, the upper two having about one-third of their height sawed off and their bottoms being perforated with a number of small holes. Into the upper barrel a water pipe is led, ending preferably in a horizontal branch, which is perforated with a number of small holes. The two short barrels are filled about half-full with salt, preferably rocksalt, the middle one being provided with an opening in front for the purpose of filling, and when water is turned on at the top it percolates through the salt in the two short barrels and arrives in the bottom one at the proper strength, where it can be drawn off by means of a faucet.

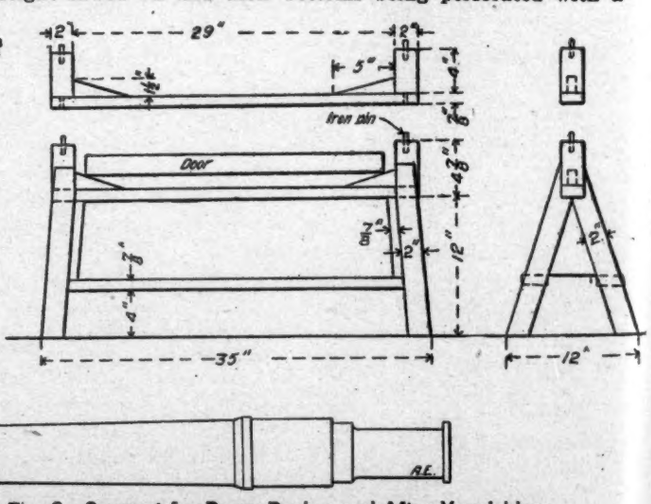


Fig. 3.—Support for Doors During and After Varnishing.

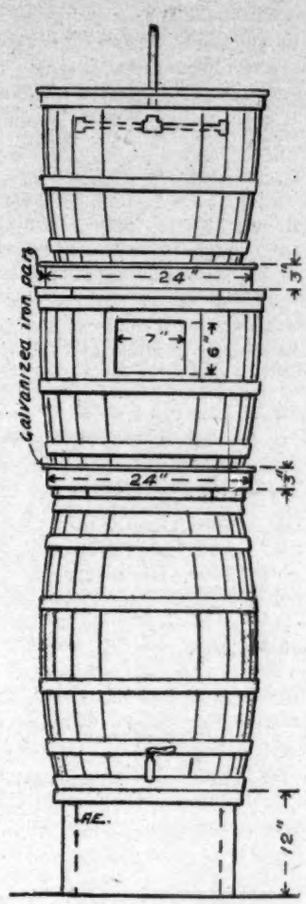


Fig. 2.—Apparatus for Saturating Water with Salt for Baker Heaters.

To prevent the salt-water from running over the sides and the salt crystallizing there, making a very untidy appearance, galvanized iron pans are placed under the two short barrels, the center of the pans being dished and provided with a large hole or a number of small ones for the water to pass through.

Surfaces which, after being varnished, are placed in a horizontal position until the varnish is "set," always present a better and more uniform appearance than when they are dried in vertical positions. In most paint shops where passenger car work is done racks are provided for drying the sash and blinds horizontally, but the doors are usually put in a vertical position as soon as the varnish has been applied.

The appliance shown in Fig. 3 allows the doors to be varnished in a horizontal position and to be left there after being varnished, and any reasonable number of doors can be superimposed on one another without occupying more than a small amount of space. The arrangement consists of two horses about 12 ins. high, made of light wood, each provided at its ends with two beveled pieces on which the door rests, touching only at the corners; the two posts on the ends of the horses project high enough above the door to allow other supports, made like the tops of the horses, to be placed upon these, to take another door; pins and corresponding holes in the top and bottom of these supports prevent their moving after being placed in position. The number of doors which can thus be placed is limited only by the height at which they can conveniently be handled without taking up more floor space than enough for one door.

IMPROVED JOINT FOR PISTON PACKING RINGS.

The accompanying engravings illustrate a new form of joint for piston packing rings, designed and patented by Mr. Millard F. Cox, Chief Draftsman of the Richmond Locomotive Works. Its purpose is to free the ordinary split packing rings, particularly of large pistons, from the difficulties of leakage and the wear caused by the access of the steam to the ends of the rings at the joints. This pressure tends to expand the rings and wear the cylinders, particularly at the ends, where the steam pressure is greatest.

The engravings make the construction clear. At the ends of the packing rings a socket is cut in the piston, into which a plug fits loosely enough to permit of self-adjustment, and this

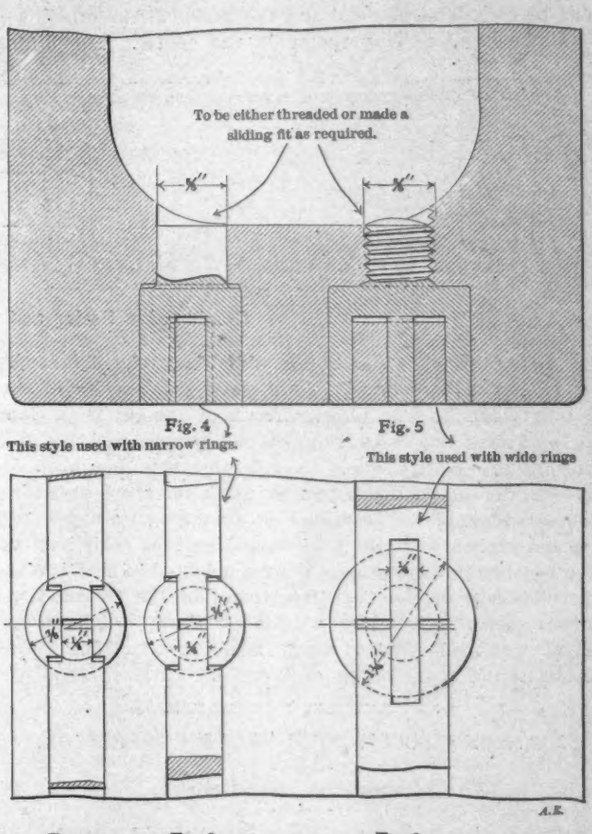

To be either threaded or made a sliding fit as required.
Fig. 4
This style used with narrow rings.
Fig. 5
This style used with wide rings
A.E.

Fig. 1 Fig. 2 Fig. 3

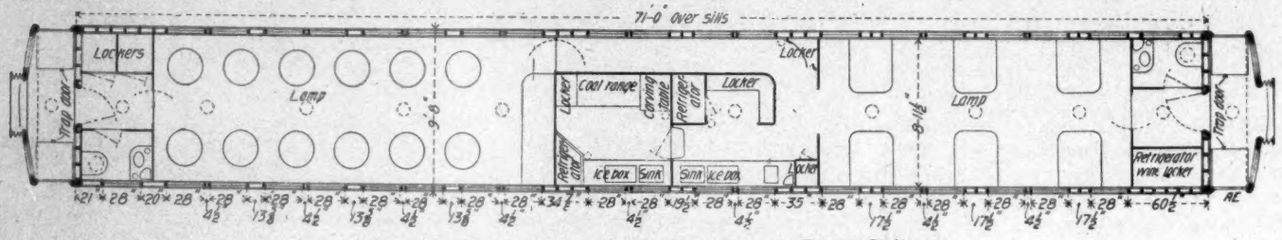
plug is cut to receive the ends of the rings, as shown in Figs. 1 and 2, or as in Fig. 3. In Fig. 3 the plug has a rib across its central portion, and the rings are slotted to fit it closely. Upon the back of the plug is an extension, shown in Figs. 4 and 5. This fits a hole made smaller than the main cavity and it serves to assist in centering the larger hole, while the extension increases the effectiveness of the bearing of the plug. The plug may be threaded into this hole, as indicated in Fig. 5, which illustrates the construction used with wide rings. It will be seen that this joint, as shown in Figs. 1 to 4 inclusive, forms essentially a part of the packing ring. It may adapt itself to outward or inward movements of the ring, and yet be tight against leakage, and the ends of the rings are not exposed to the steam pressure. The walls of the plugs are fitted flush with the wearing surfaces of the rings.

Large cars for English railroad conditions came up again in Mr. J. A. F. Aspinall's presidential address before the Liverpool Engineering Society. It appears that, however desirable they are from an operating standpoint, the coal operators control the situation. The railroads own about 677,000 cars and the private coal companies own about 550,000. The docks and unloading facilities are all adapted to present equipment and it will be a difficult matter to change.

CAFE-PARLOR CAR FOR FAST EXPRESS SERVICE.

Grand Trunk Railway.

Two very striking composite cafe-parlor cars have just been completed at the Point St. Charles shops of the Grand Trunk Railway, for use on the Montreal and Toronto fast express trains, the "International Limited" and the morning train leaving Toronto for Montreal at 9 o'clock. These cars are of large dimensions, 71 ft. long over end sills and 9 ft. 8 in. wide over sheeting. The vestibules are the Pullman standard type with steel platforms. The windows are large and the roofs of the Monitor type. The cars are mounted on 6-wheel trucks with steel-tired wheels. It will be seen from the engraving of the plan view of one of these cars that the dining-room, or cafe, is at one end and the parlor at the other, with the kitchen and serving rooms in the center. The dining-room seats 24 people at the tables, while the parlor is furnished with twelve large revolving chairs and a sofa capable of seating four persons. The interior finish of the car is in Canadian quartered oak with English oak panels, and the floor coverings are Walton pile. Considerable skill has been displayed in the interior arrangement, using the space to the best possible advantage. The matter of arranging ice-boxes, pantries and cupboards in the kitchen and waiters' room has been given considerable attention. We are indebted to Mr. McWood, Superintendent of the Car Department of the Grand Trunk Railway, for the drawings of this car from which our engraving was made, and to whom much credit is due for his success in the construction of these fine cars.



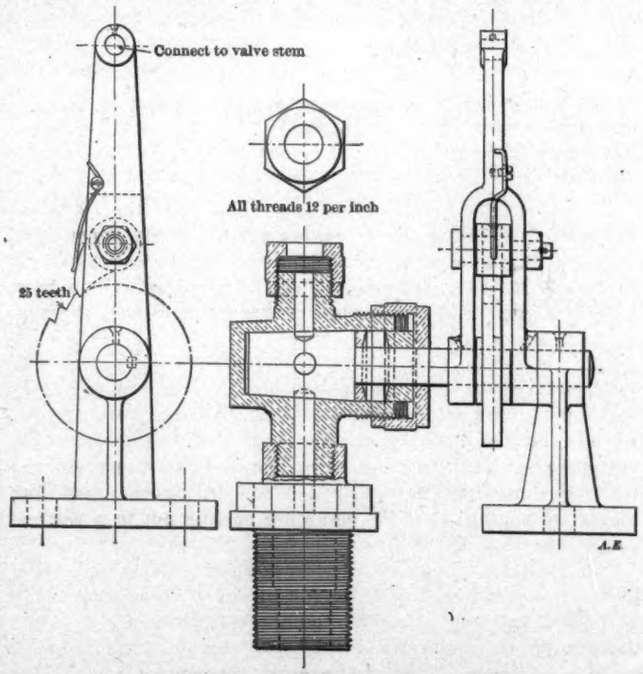
Combination Parlor and Cafe Car.—Grand Trunk Railway.

JOHNSON'S LOCOMOTIVE VALVE LUBRICATOR.

Chesapeake & Ohio Railway.

In common with other roads the Chesapeake & Ohio has had difficulty with the lubrication of locomotive valves with increased steam pressure and has tried various methods to improve the delivery of oil to the valves in order to insure regular and uniform lubrication. The nature of the difficulty is too well understood to require explanation here, and while fair success has been secured by various attachments to overcome the influence of the fluctuating pressure of steam from the steam chest, none have worked so nearly to the satisfaction of the officers of the motive power department of that road as the device which is illustrated here through the courtesy of Mr. W. S. Morris, Superintendent of Motive Power. This device, which has now been working successfully for a year, was patented by Mr. W. F. Johnson, a locomotive engineer on the Chesapeake & Ohio. Fourteen of them have been made and are soon to be applied. It is the intention to equip all engines with them as fast as they can be made and applied.

The engraving illustrates the construction. No change is made in the cab, and the usual sight-feed lubricators are employed to feed the oil into the "tallow pipes." At the steam chest end of this pipe a device is connected which resembles a plug cock. The plug, however, instead of being cut through is provided with several cavities drilled a short distance into it and arranged at equal distances around its circumference. This plug is turned by a ratchet driven by a rod from the valve stem, and as it turns, the holes successively fill with oil from the pipe and carry it around to be deposited into the steam chest. The plug is packed with asbestos, as indicated, against leakage from the casing and the gland screws up against a shoulder so that it will not jam the plug into the casing. The office of the rotating plug is to overcome the effect of the steam-chest pressure and prevent it from acting on the column of oil in the pipe. This it does effectually, and Mr. Morris speaks of it unhesitatingly as the most satisfactory method for lubricating locomotive valves working with high pressure steam that he has seen. It is very simple and certain of action, and the attachment to the valve stem seems to be equally satisfactory. The amount of oil fed is dependent upon the speed and the travel of the valve. The valves receive the most oil when the engine is working hard with long cut-offs, because then the strokes of the valve stem is greatest and the pawl passes over the greatest number of notches of the ratchet. At high speeds and short valve travel the stroke is shorter and the delivery corresponds to the demand. There has been no appreciable wear in a year's service, and there is no tendency for the plug to leak steam into the oil pipe, because the pressure is greatest from below, which tends to press the plug up against the top of the casing. The device seems to be very well designed, and it is inexpensive. Apparently a simple form of oil cup will suffice in the cab, but thus far it has been thought best to make no change there.



Johnson's Locomotive Valve Lubricator.
Chesapeake & Ohio Railway.

Oil pumps mounted on the steam chest and driven from the valve stem are giving good service in the West, but this device offers the advantage of the oil pump combined with the sight feed in the cab, which Mr. Morris considers highly desirable. There seems to be a wide field for a device of this kind, and it appears to be all that is necessary to render the present sight feed lubricator entirely satisfactory.

CORRESPONDENCE.

LOCOMOTIVE CLASSIFICATION.

To the Editor:

Your article on this subject in your October issue is both timely and forceful, and, as it seems to me, a complete and perfect remedy for the confusion which we have already reached is found in the suggestion of Mr. F. M. Whyte, which you present. It possesses the controlling merits of being logical, simple, and covering the ground so fully and clearly as to be incapable of doubt or misunderstanding by anyone of ordinary intelligence, and I can see no reason why it should not be at once and universally adopted. It is not, to my mind, open to any unfavorable criticism, and I do not think that any suggestion of a better plan can be offered.

One of the abuses of the present arbitrary nomenclature which has lately become prominent, not merely in journals which do not pretend to be technical, but also in those which are strictly so, is the misuse of the word "consolidated" for "consolidation," and of "mogul" when referring to a ten-wheel six-coupled engine. The eight-coupled engine with two-wheel leading truck (2-8-0 under Mr. Whyte's classification) has no feature, either structural or operative, to which the word "consolidated" would be applicable in any sense, and it is a matter of common knowledge that the type took its name from that of the first engine constructed with such a disposition of wheels —i.e., the "Consolidation," which was built by the Baldwin Locomotive Works for the Lehigh Valley Railroad in 1866. While engines of this and of the "Atlantic" type have ten wheels, they have never, so far as I have observed, been termed "ten-wheel" engines, and the latter designation has been, from the first, applied to six-coupled engines with four-wheeled leading trucks. That type has been so long and so universally known as the "ten-wheel," that either ignorance or carelessness must be the only basis for the comparatively recent practice of calling them "moguls," particularly in view of the fact that the six-coupled engine with two-wheeled leading truck has been known as a "mogul" ever since the first one was built.

While the present nomenclature may be of some slight value for mere advertising purposes, it presents no identifying characteristics, and with the production of new designs, tends additionally to confusion. An intelligent and reasonable system, such as that proposed by Mr. Whyte, should by all means be substituted for it.

J. Snowden Bell.

Pittsburgh, December 8, 1900.

To the Editor:

In offering a criticism of the very simple yet ingenious scheme of locomotive classification devised by Mr. Whyte, and described on page 374 of your December number, 1900, the writer is reminded of the lesson of the "importance of some things" thrust upon the engineer, who, meeting with an accident crippling his tender, wired to headquarters for instructions. The order, to "disconnect, load some wood on a flat car, couple and proceed," was concise, if not logical.

The tender, which we are so prone to lose sight of, is a necessary adjunct to a locomotive and its form is variable. The ease with which it may be embodied in such a classification system seems to me one of the arguments favoring its adoption. Again we have the outside connected engines and our foreign cousins have the inside. Further, quoting, "the tendency is to give a type designation to a new design the only peculiarity of which is the outside or inside journals of the trailing wheels."

Taking all into consideration, we would write $\frac{4-2-2}{6}$, as representing an engine with 4-wheel truck-single pair inside connected drivers, with a pair of trailers with inside bearings, with a 6-wheel tender; wh.e $\frac{4+4+2}{4,4,}$ would represent a type with 4-wheel leading truck, 4 outside connected drivers, a pair of trailers with outside bearings, with the regulation tender.

Here the numerator gives the engine, the denominator the tender. The minus sign before the drivers indicating inside connections, before trailers means inside bearings, and the plus sign the outside in each case. The bob-tail engine would then be $\frac{6}{0}$.

G. S. Edmonds,
Mechanical Engineer,
Delaware & Hudson Co.

Green Island, N. Y., December 5, 1900.

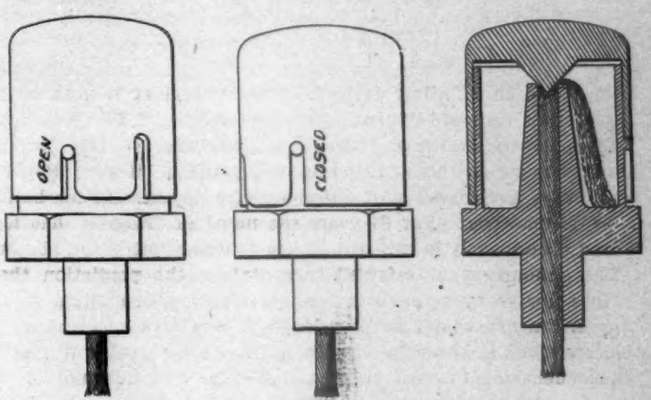
AN IMPROVEMENT IN OIL CUPS.

To the Editor:

Being a reader of your paper and knowing that it falls into the hands of all the thinking and leading railroad men who seem to be looking for everything that is new and good, I thought a new device which I saw the other day might be of some interest to your readers.

There is a guide oil cup being used on some of our largest railroads with great economy in oil and meets with great favor among the engineers, and unless I am mistaken it has never been illustrated.

I happened to see this cup one day in strolling around a neighboring engine house and obtained all of its good points from one of the engineers who had a full set on his engine. He stated that it was the cleanest cup he ever saw and the most



A Simple Rod Cup.

convenient, with nothing to get out of repair; it requires no tools, not even for adjusting, and is a positive feeder. To start or stop the flow of oil one has merely to raise the cover, change its position and drop it again. The number of miles run per pint of oil with this cup, comparing it with any other cup of the same size, is about 900 miles against 150.

I enclose you a pencil sketch of the cup showing its simplicity. You will readily see that it needs only the raising and lowering of the cover of the oil cup by hand to regulate the flow of oil. When the cup is feeding the cover is raised off the wick and seat, resting on the pin in the short slot. To stop the cup from feeding the cover is changed so that the pin will be in the long slot, the cover falling by gravity, resting on the wick and seat.

The cup I notice has been patented and is being introduced by J. S. Coffin as General Agent, Franklin, Pa.

Locomotive Engineer.

ARRANGEMENT OF VIEWS ON DRAWINGS.

To the Editor:

Bad practice prevails in a good many drawing-rooms in the matter of placing the several views on a drawing. I refer to the placing of the plan beneath the elevation. The most natural place for a plan view in relation to an elevation is above, not beneath it, and the reason is this: A drawing, which is always read by its two or three views, is more easily and quickly read when the projecting points of two views are brought nearer together. As an example of this, take the simplest of objects, a lead-pencil 8 ins. in length, sharpened to a point 1-16 in. in diameter. Placing the pencil in an upright position for the elevation, and then drawing the plan beneath it, throws the 1-16 in. circle representing the pencil point in the plan over 8 ins. from its projected lines in the elevation; whereas, if the plan had been placed over the elevation, the projected points would have been very near to each other. The same thing is true in the drawing of almost any object. If the placing of the plan view over the elevation is correct, then

following the same practice it would be correct to place an end view at that end of the elevation for which it is intended to represent, so that one's eye would not be obliged to traverse the entire length of the object to get the points projected. I think this point is worth the attention of those who have drawings to make or the supervision of those who make them.

A. H. Weston,
Chief Draftsman,
Atlantic Coast Line.

The purchase of the Pennsylvania Coal Company by the Morgan interests is a very important move, because it defers or possibly completely stops the building of an independent road to carry Pennsylvania coal to tide-water. The plan was to build a line 95 miles long from Hawley, Pa., to Rondout, N. Y., the right of way acquired being that of the old and disused Delaware & Hudson Canal. The purchase of the coal property has probably settled the question, and the road is not likely to be built. It seems absurd to consider the construction of more roads when the coal fields are so abundantly supplied.

The Rogers Locomotive Works, which were formally closed December 1, have recently been the subject of negotiation which may lead to their being started up again, but at this date nothing has been definitely decided. It is interesting to note in the American Railroad Journal (the predecessor of The American Engineer and Railroad Journal), of December 24, 1836, an announcement of the addition to the plant of Messrs. Rogers, Ketchum & Grosvenor of Paterson, of a department for building locomotives. For 64 years the name of "Rogers" has figured prominently in railroad circles of this country and abroad. The announcement referred to contained the prediction that "In a few years we shall not see an imported locomotive on an American railroad." In these days of extensive exportation of locomotives it is difficult to realize that this country was ever dependent for them upon England. The first locomotive by these works was finished in 1837.

In his paper at the last meeting of the American Society of Mechanical Engineers Mr. William Sangster presented some interesting facts regarding fan blower practice in connection with cupola furnaces and forges. He points out that "in hardly any other class of machinery is the method of application of so great importance as it is in the case of centrifugal fans. The conditions of one installation are usually so different from those of any other that hard and fast rules are out of the question." Briefly summarized, he shows that the horse-power required to produce blast for a cupola is equal to three-tenths of the number of tons melted per hour multiplied by the pressure of blast in ounces per square inch. For forge blast an allowance of one-quarter horse-power may be made per forge, and for exhausting smoke therefrom the power required will be 0.44 horse-power per forge.

PERSONALS.

Mr. Walter J. Thomas has been appointed Master Mechanic of the Chesapeake & Ohio at Louisville, Ky.

Mr. Edward Needham has been appointed Assistant Master Mechanic of the Wabash shops at Decatur, Ill.

Mr. J. J. Monahan, has been appointed Master Mechanic on the Louisville & Nashville, with headquarters at Memphis.

Mr. Thos. S. Stevens has been appointed Signal Engineer of the Atchison, Topeka & Santa Fe, to succeed Mr. J. S. Hobson, resigned.

Mr. Thos. D. Moore, General Superintendent and Purchasing Agent of the Cheat Valley Railway, with office at Manheim, W. Va., has resigned.

Mr. D. Witherspoon has been appointed Master Mechanic and Master Car Builder of the Washburn, Bayfield & Iron River, with headquarters at Washburn, Wis.

Mr. S. K. Dickerson has resigned as Master Mechanic of the Lake Shore & Michigan Southern at Cleveland, O., to take a similar position on the Atchison, Topeka & Santa Fe.

Mr. F. C. Gates, Purchasing Agent of the Wheeling & Lake Erie, has resigned and Mr. J. T. Stark, under the supervision of President Blickensderfer, will perform the duties of that office.

Mr. W. A. George, General Foreman of the shops of the Colorado Midland at Colorado Springs, Colo., has been appointed Master Mechanic of the Colorado & Southern at Denver, Colo.

Mr. R. A. Dugan, heretofore Purchasing Agent of the Elgin, Joliet & Eastern, has been appointed Assistant General Manager of this company and the Chicago, Lake Shore & Eastern, with headquarters at Joliet, Ill.

Mr. E. E. Hudson, Master Mechanic of the Cleveland, Cincinnati, Chicago & St. Louis, at Bellefontaine, O., has resigned and will go to Cleveland, O., to take charge of the shops of the Lake Shore & Michigan Southern.

Mr. N. Kirby, Master Mechanic of the Mobile & Ohio at Tuscaloosa, Ala., has been appointed Master Mechanic at Whistler, Ala., vice Mr. D. O. Smith, resigned. Mr. T. E. Harwell, heretofore Foreman at Okolona, Miss., succeeds Mr. Kirby, with headquarters at Tuscaloosa.

Mr. W. J. Underwood, formerly General Superintendent, has been appointed Assistant General Manager of the Chicago, Milwaukee & St. Paul Railway, and Mr. C. A. Goodnow succeeds him as General Superintendent. Both have been connected with this road for a number of years.

Mr. L. S. Chadwick, formerly Superintendent of the Ball Bearing Company, of Boston, and later with the International Time Recording Company, has accepted the position of Superintendent of the Searchmont Motor Company, of Philadelphia. Mr. Chadwick's experience after graduating from Purdue University in 1899 has been such as to make him well fitted for his new duties.

Mr. Angus Brown, who recently resigned as Superintendent of Motive Power of the Wisconsin Central, was tendered a farewell banquet and reception on November 29 by the employes of that road. During the evening Mr. Brown was presented with an embossed copy of a set of resolutions adopted by the railway men's organizations, as a token of the high regard in which he was held by those who had worked under him.

Mr. William Swanston, Master Mechanic of the Pittsburg Cincinnati, Chicago & St. Louis at Indianapolis, Ind., who has been in continuous railway service for over fifty years, will retire on January 1st, under the provisions of the pension plan. Mr. Swanston is seventy-three years of age and has earned a high place in the esteem of a great many friends. He is one of the best-known motive power officers of the Pennsylvania system.

Mr. J. S. Turner, Superintendent of Motive Power of the Fitchburg Railroad, has been appointed Superintendent of Motive Power and Equipment of the Toledo, St. Louis & Western Railroad, with headquarters at Frankford, Ind., effective January 1. Mr. Turner is equipped with a wide and valuable experience on the Pennsylvania, the Mexican Central, West Virginia Central, Colorado & Southern, and the Fitchburg roads. He is a valuable acquisition to the "Clover Leaf."

THE WESTINGHOUSE-PARSONS STEAM TURBINE.

While the steam turbine is one of the most interesting of recent steam power developments, comparatively little has been published upon the theory of the machines. For this reason and because of the apparent success of its introduction into this country, an elaborate paper upon the general subject of steam turbines, recently read by Mr. Francis Hodgkinson before the Engineers' Society of Western Pennsylvania is specially timely. Mr. Hodgkinson was identified with Mr. Chas. A. Parsons in the development of the turbine in England, and

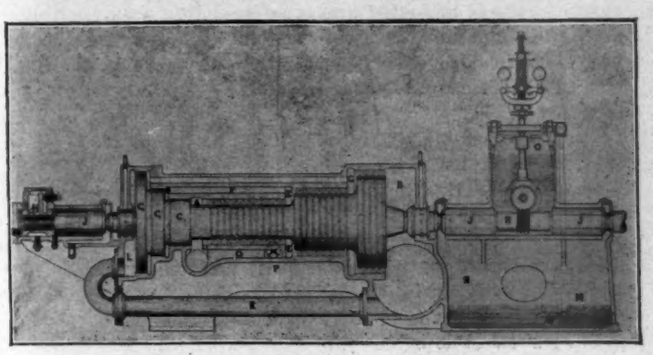


Fig. 1.

under his direction the Westinghouse Machine Company has adapted Mr. Parsons' practice to American conditions.

From the historical part of the paper it appears that the origin of the steam turbine dates back to 120 B. C. Banca's machine was made in A. D. 1629, while the reciprocating engine came in 1705. One of the earliest of Mr. Parsons' experiments with a 20-horse-power turbine, constructed on the lines of Hero's engine, showed a steam consumption of 40 lbs. per brake horse-power, and it is remarkable that Hero's engine was more economical than any engine produced for twenty centuries later.

The author of the paper confines his attention to the De Laval and Parsons systems. The former employs several jets of steam impinging against curved blades set in a single ring, the entire expansion of the steam taking place at the jets. This necessitates enormously high speeds and requires gearing

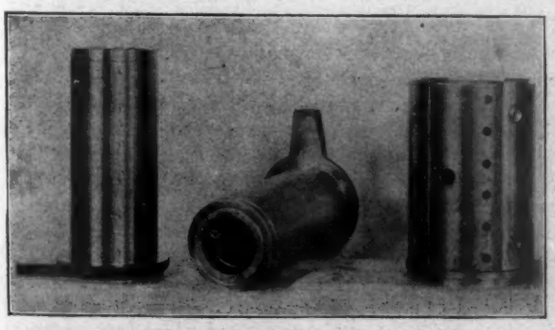


Fig. 2.

to bring the speeds down so that they can be used. It is presumed that the reader is familiar with the two types. The De Laval turbines run at about 30,000 revolutions per minute for the smaller sizes and 10,000 revolutions for the larger ones.

Mr. Hodgkinson goes into detail to an extent which makes it impossible for us to do more than convey a general idea of his paper. We aim chiefly to present those portions which will supplement the description of the Westinghouse-Parsons steam turbine, printed on page 65 of our March issue of last year, concerning the installation at the works of the Westinghouse Air-Brake Company. By aid of the accompanying diagrams the action of the steam is made clear.

Fig. 1 is a general longitudinal section through a Westinghouse-Parsons steam turbine. The steam enters at the governor valve and arrives at the chamber A, and passes out to the right through the turbine blades, eventually arriving at the exhaust chamber B. The blades are shown in Fig. 3, the steam passing first a set of stationary blades and impinging on the moving blades, driving them around, and so on. On the left of the steam inlet are shown revolving balance pistons, C, one corresponding to each of the cylinders in the turbine, which, according to size, may be from one to four in number. The steam at A presses against the turbine and goes through, doing work. It also presses in the reverse direction, but cannot pass the piston C; but at the same time the pressure, so far as the steam at A is concerned, is equal and opposite, so

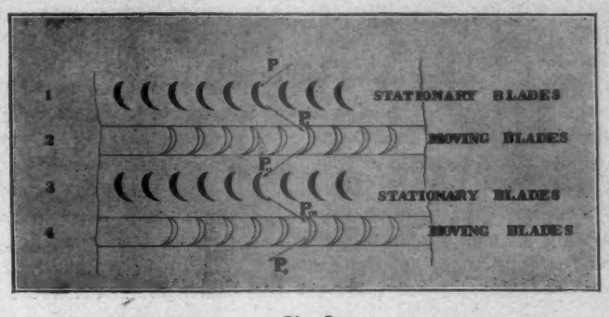


Fig. 3.

that the shaft is not subjected to any end thrust. The pressure at D is equal to that at E by reason of the balance port F, so, similarly, so far as the steam pressure at E is concerned, there is no end thrust. This same fact also applies to G. The area of the balance pistons is so arranged that no matter what the load may be, or what the steam pressure or exhaust pressure may be, the correct balance is preserved and the shaft has no end thrust whatsoever. The thrust or adjustment bearing (for it has no thrust) is in two halves, the lower half capable of adjustment in one direction, the upper one in the reverse.

There is obviously some leakage past the pistons, but it is found to be very small. Centrifugal force seems to have something to do with keeping down this leakage. The particles endeavoring to escape have to pass radially inward in going through the small clearance. It is supposed then, that the

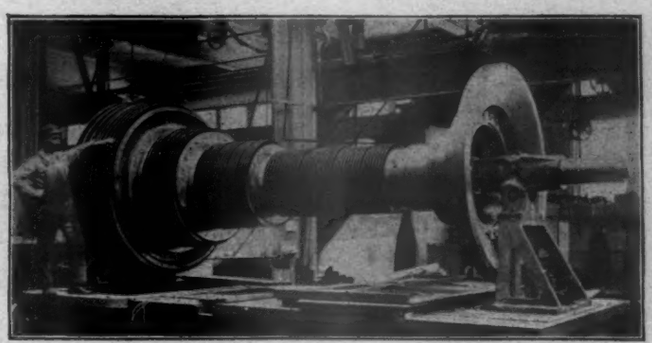


Fig. 4.

rapidly revolving pistons have the effect of throwing outward the particles with which they come in contact by reason of skin friction, so that the particles being slung outward tend to oppose the escape of the particles inward. This theory, however, is somewhat imaginary, but in view of the economy obtained, the leakage cannot be very great.

At K is a pipe connecting the back of the balance pistons at L with the exhaust chamber (see Fig. 1) to insure the pressure at this point, being exactly the same as that of the exhaust. At J are shown the bearings. They are also shown separately in Fig. 2. They are unique in construction. The bearing proper is a gun-metal sleeve, which is prevented from turning by a loose-fitting dowel. Outside of this are three

concentric tubes having a small clearance between them. This clearance fills up with oil and permits a vibration of the inner shell, at the same time restraining it. The shaft, therefore, revolves about its axis of gravity instead of the geometric axis, as would be the case were the bearing of everyday construction. The journal is thus permitted to run slightly eccentric, according as the shaft may be out of balance. This form of bearing in a very remarkable manner performs the functions of De Laval's slender flexible shaft. But in this case the shaft is built as rigidly as possible, and is not liable to crystallization, which would result in eventual rupture. The bearings have ample surface, are continuously lubricated under pressure, and it has been found in practice that they do not wear. As may be seen in Fig. 2, the bearings are surrounded by an outer cast-iron sleeve, in which are fitted keys which may be shimmed up and permit of adjustment of the position of the shaft relative to the cylinder. At R, Fig. 1, is shown a flexible coupling by means of which the power of the turbine is transmitted. In small sizes the two shafts have a square cut on the ends, the coupling itself somewhat loosely fitting over these. In larger sizes it is generally a modification of this arrangement.

The governor gear and oil pumps generally receive their motion by means of a worm wheel, gearing into a worm cut on the outside of the coupling. At H is an oil reservoir, into which drains all the oil from the bearings. From there it

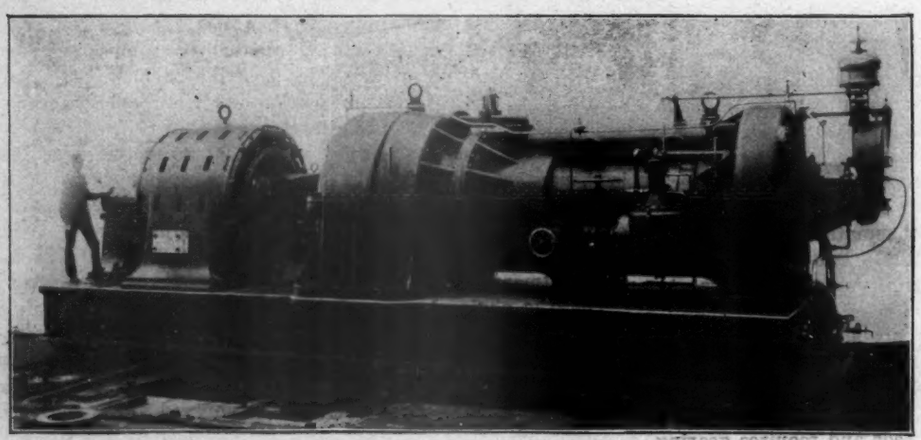


Fig. 5.

runs into the pump M, to be pumped up to the chamber O, where it forms a static head, which gives a continuous pressure of oil to the bearings. The pump is single-acting, of the simplest possible construction, that will not become deranged. The oil runs in by gravity, so that it is unlikely to fail to continue pumping.

A by-pass valve is provided, shown at P, which admits high-pressure steam by means of port Q to the steam space E. By opening this valve as much as 60 per cent. overload may be carried, and in the case of turbines operating condensing, full load may be obtained should the condenser be at any time inoperative, and the turbine allowed to exhaust into the atmosphere. Naturally, the effect of opening the by-pass valve is to reduce the economy.

The glands consist of packing rings set in grooves cut in the shaft. The rings press outward and remain stationary. Any form of frictionless packing necessarily leaks a little. In the case of the turbine exhausting into a vacuum a little less live steam is admitted between the rings by means of a small reducing valve, so that the leakage consists of a negligible quantity of live steam, instead of air, which would impair the vacuum.

While the steam admission and the construction are intensely interesting, these must be passed over with the statement that the admission valve works intermittently, the duration of the opening depending upon the governor. With this admission there is no wire-drawing of the steam, and the admission valve is continuously in motion, which guards against the possibility of its becoming stuck. As regards the regulation, it may be said that there is absolutely no variation of angular velocity in the turbine, such as is necessarily present in reciprocating engines, hence the value of turbines for running alternators in multiple. This is appreciated when we are told that a 500-horse-power turbine will run twenty minutes after the throttle is closed.

The essential parts of the turbine are the blades and buckets, which are made of hard-drawn material, securely fixed in grooves in the rotating element. Every row of these blades has passages of increased area, corresponding with the volume of the steam, this increase being obtained by increasing the height of the blades. When the limits are reached the diameter of the rotating element is increased and the steam permitted a higher velocity, which enables the blades to begin another progression. This explains the several diameters of the revolving element.

Referring to Fig. 3, the steam at pressure, P, in expanding through row 1 to pressure, P_1, converts its energy into velocity and impinges upon the moving blades, row 2. The steam then performs a second expansion in expanding through row 2, again converting its energy into velocity, but this time the energy of the efflux is to react upon the blades from which the steam issues. The same cycle is repeated in 3 and 4, and so on until exhaust pressure is reached. The moving blades therefore receive motion from two causes, the one due to the impact of steam striking them, the other due to the reaction of the steam leaving them.

In a 300-kilowatt unit the turbine has 31,073 blades, of which 16,095 are on the moving element. The pressure that each of them exerts on the shaft varies from 0.89 to 1.04 ozs. The economy of the turbine of the size just mentioned may be taken at 14 lbs. of steam per indicated horse-power when running at full load, and the figures taken from a service test at the Wilmerding Shops were given in the American Engineer, April, 1900, page 116. Professor Thurston has recently recorded experiments showing that with 37 degrees of super-heat the capacity of a small turbine was doubled. This indicates that even better results may be expected in the future.

Fig. 4 illustrates the complete revolving element of a 3,000-horse-power turbine, which is now being erected in the power house of the Hartford Electric Light Company. This illustration gives an excellent idea of the arrangement of the moving blades and their enormous number. The weight of the revolving part is 28,000 lbs.; it is 19 ft. 8 ins. over all and its largest diameter is 6 ft. This will be direct-connected to a 1,500 kilowatt generator, and this is the largest steam turbine ever built.

The steam turbine, while not universally applicable for the work done by ordinary steam engines, appears to be particularly well adapted to the driving of electrical generators, where uniform speed is required, as for alternating-current machines.

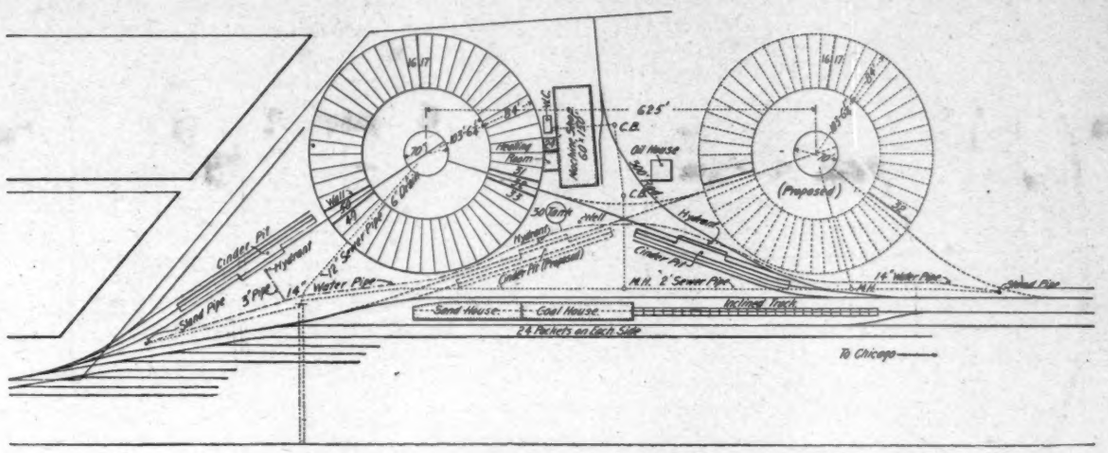
The paper concludes with a summary of the progress of the steam turbine in marine propulsion. The author of the paper states that in a power house in England, containing eleven turbines of from 75 to 150 kilowatts each, the cost of repairs and renewals amounted to 26 cents per kilowatt per annum, including all repairs to boilers, turbines, condensers, pumps, generators and electrical apparatus.

The Cambria Steel Company has taken up the manufacture of steel cars.

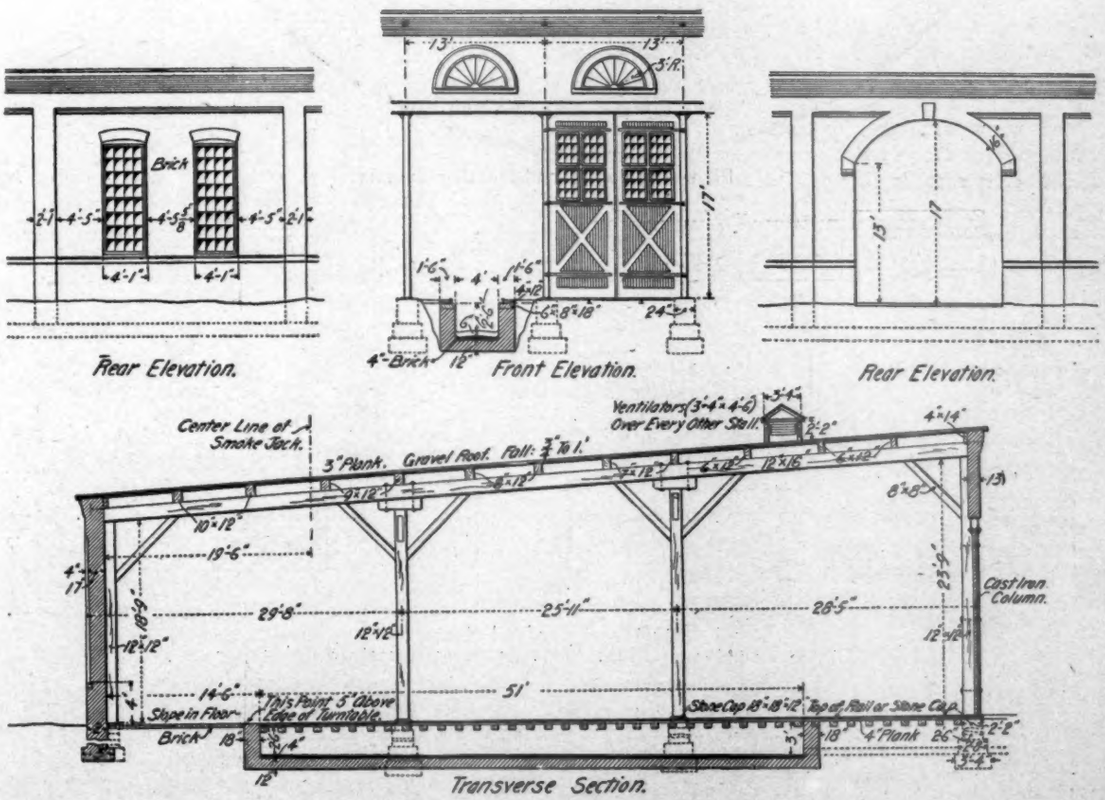
A MODERN HOUNDHOUSE,

Chicago & Northwestern Railway, at Clinton, Ia.

The large and thoroughly equipped roundhouse plant of the Chicago & Northwestern Railway at Clinton, Ia., is an example of improvement in a direction toward which comparatively little attention has heretofore been given, and because of its influence upon the service of locomotives it is an important one.



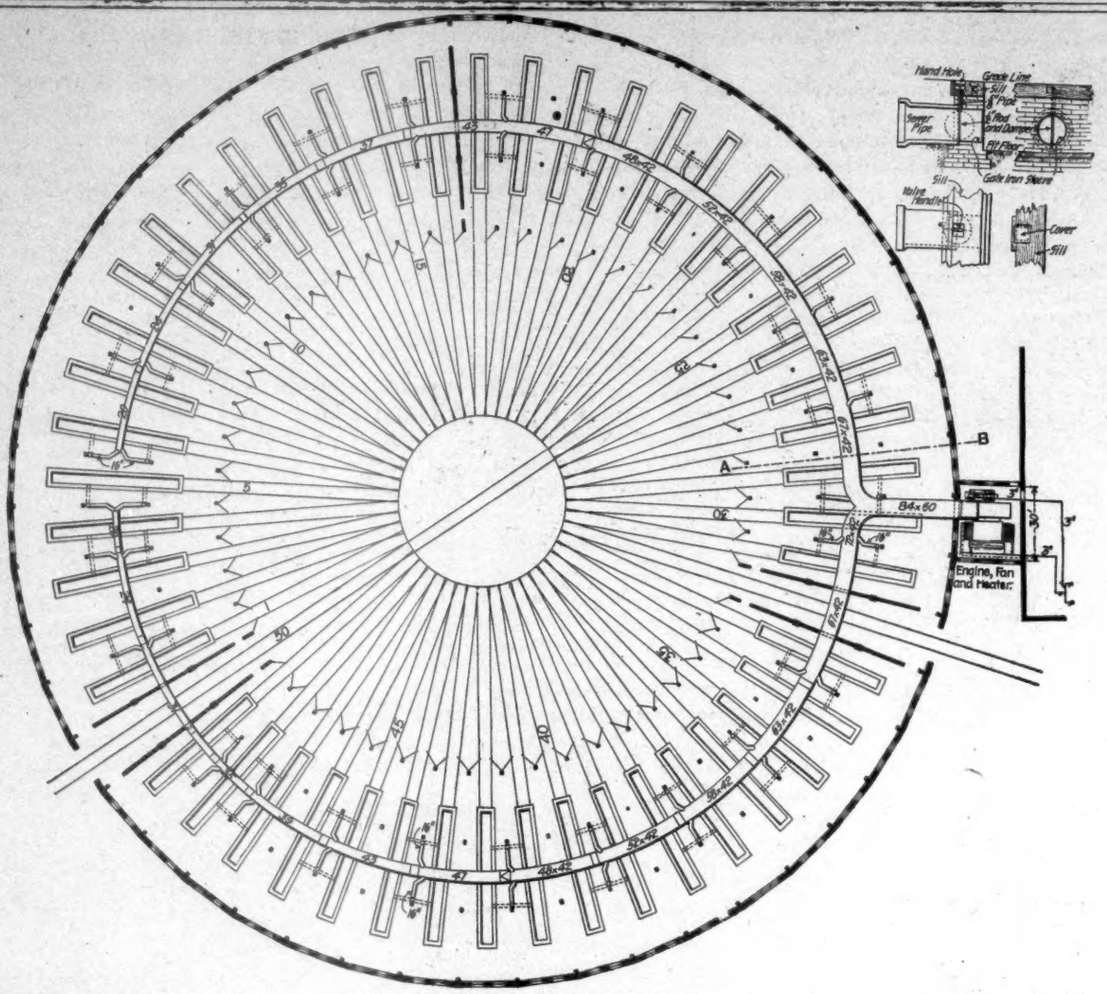
Roundhouse Plant.—Chicago & Northwestern Railway, Clinton, Iowa.
Plan of Tracks, Roundhouse and Proposed Extension.



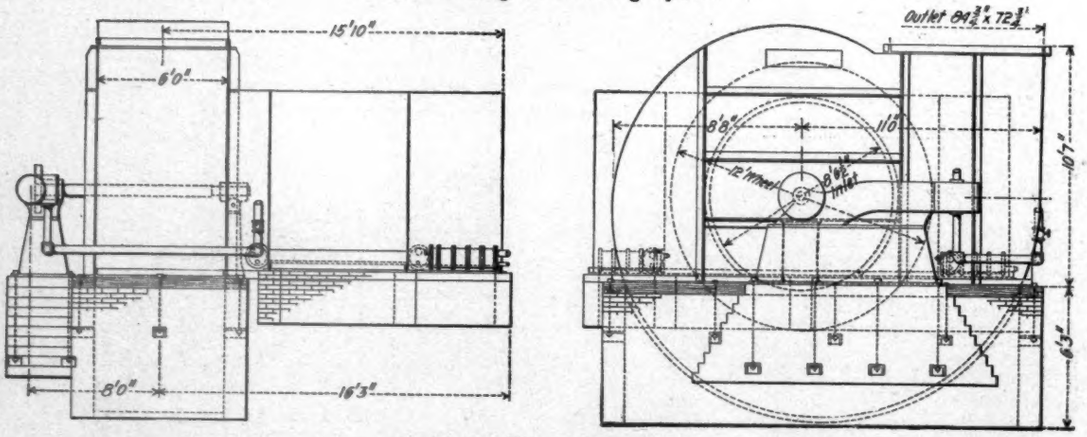
Sections and Details of Building.

This plant replaces an old one, and the development of business necessitated thorough and ample facilities for about 80 locomotives a day, Clinton being a terminal for two divisions and a branch line. The house itself and its equipment, the adjacent shops, the coal and sand chutes and ash pit are all interesting. There are 48 stalls and two spaces, the plans providing for doubling the capacity when necessary. The house is 375 ft. in outside diameter, the interior wall being 207 ft. in diameter and the turntable 70 ft. long. The tracks provide for two entrances for engines, the coal, sand and ash apparatus being conveniently located. When completed there will be three cinder pits, as shown in the plan. The shop is 60 x 150 ft. in size and behind it is the oil house, the arrangement being such as to eventually bring these buildings between the two roundhouses.

The accompanying engravings illustrate the construction in detail and present the chief dimensions. The outer walls are of brick, upon rubble masonry foundations, the inner walls being of cast-iron columns at 13-ft. centers, between the rectangu-



Plan of Building and Heating System.



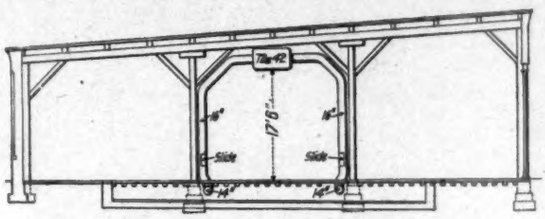
Sturtevant Fan and Heater.
Clinton Roundhouse Plant.—Chicago & Northwestern Railway.

lar doors, which are 17 ft. high. The columns support 10-in. channels, upon which the inner brick wall is laid over the doors. The roof is of 3-in. plank upon timber framing. It slopes ¾ in. to the foot and is covered with gravel roofing. Every second stall has a wooden ventilator and each stall a cast-iron smoke jack. The pits are 51 ft. long, the sides and ends are of rubble masonry and the floors of brick, sloped toward the turntable for drainage. The floor between the pits is of hard-burned brick. Water and compressed air are carried by pipes to each pit, and the pits are all fitted with pipe connections to receive the steam and water blown off from the engines. The ash hoist was illustrated in our issue of September, 1900, page 278. It was designed by Mr. G. R. Henderson, Assistant Superintendent Motive Power of the road, and is reported to be very satisfactory.

The shop is well equipped with machinery and it serves to relieve the repair shops of a large amount of small work. The oil house, 33 by 35 ft., has underground tanks, from which the oil is raised by air pressure.

The heating system is an admirable feature. It not only renders the buildings comfortable and ventilates them, but in the winter months serves in an important way to facilitate the turning out of engines by rapidly melting the ice and snow from the running gear by introducing heated air in the pits and directly under the engines. The B. F. Sturtevant Company, of Boston, were the contractors for this system, of which our engravings illustrate the arrangement. A small building between the roundhouse and shop contains the Sturtevant steel plate fan wheel, 12 ft. in diameter, placed in a steel-plate casing with an upward discharge. A direct-connected 11½ by 16

in. horizontal Sturtevant engine drives the fan, and its exhaust steam is used to furnish a part or the whole of the heat for the buildings, depending upon the severity of the weather. The fan is independent of other machinery, and its speed may be regulated as desired. Air is drawn by the fan through a heater having 20,000 ft. of 1-in. pipe built of Sturtevant sections in three groups and inclosed in a steel-plate casing. From the heater the air is led to a large horizontal duct of galvanized iron, which branches in both directions about the building over the centers of the pits and near the roof, where it is out of the



Arrangement of Air Outlets in the Pits.
Section at A. B.

way. The divisions meet at the side opposite the fan, and branch pipes are led downward along the sides of the vertical posts and divide below the floor so as to connect with pipes leading to the pits on each side. The vertical pipes are also out of the way and protected by the roof posts. There are more than 50 of these branch pipes, each having a damper, the circulation of air being all that can be desired. Each branch pipe to a pit has a damper and hot air may be locally delivered in large volumes in order to melt snow and ice from the engines. The hot air is also dry and readily absorbs moisture, all of which tends to assist in reducing the delays due to roundhouse work.

One of the advantages of this system of heating lies in the concentration of the heating surface in a small fire-proof casing. The heating surface used in this way is less than would be needed by direct methods. and the fuel consumption correspondingly smaller. In moderate weather the exhaust steam from the fan engine is sufficient for heating, so that the engine is run without appreciable expense, and in colder weather live steam is used in the remainder of the heater. It is, however, customary in ordinary mill practice, where there is an abundance of exhaust steam, to utilize it in the heater, which is readily done without producing back pressure on the main engines. The ease of control of the temperature is remarkable.

The rapidity with which the Marconi system of wireless telegraphy has been developed into a practical and commercial success is remarkable and very unusual. It is not often that an inventor lives to see the recognition and commercial adoption of his invention, as has been the case in this instance, and this fact serves to draw increased attention to the subject. The Admiralty of Great Britain tested it thoroughly and has decided to install Marconi's apparatus in thirty-two English war-vessels. Doubtless the mercantile marine will soon follow suit and it is likely to come into use in coastwise signaling. The United States navy cannot long do without it in view of these facts, and it seems to be an excellent subject for thorough investigation also by the army. In the English navy tests the system worked sucessfully between Portland and Portsmouth, sixty-five miles, with the high land of St. Albans Head intervening between the two terminals. In view of the fact that the English Admiralty is one of the most conservative official bodies in the world and that its satisfaction is so positively expressed, seems to indicate that this system has very swiftly passed its experimental stage.

The new station of the New York Central at Albany was used for the first time December 17. The work has been in progress for several years, and included track elevation and the construction of a subway for the passengers of the Delaware & Hudson. Its cost was about $1,000,000.

SELF-OPENING CAR WINDOWS.

The Edwards Window Fixtures.

Some greatly appreciated devices recently developed for opening car windows are those known as the Edwards window fixtures. These fixtures have met with much favor on the Pennsylvania and New York Central & Hudson River Railroads, where a large number of coaches have been equipped with them.

It will be seen from Fig. 1 that the window sash is supported by a linen mat, M, which is fastened at the lower

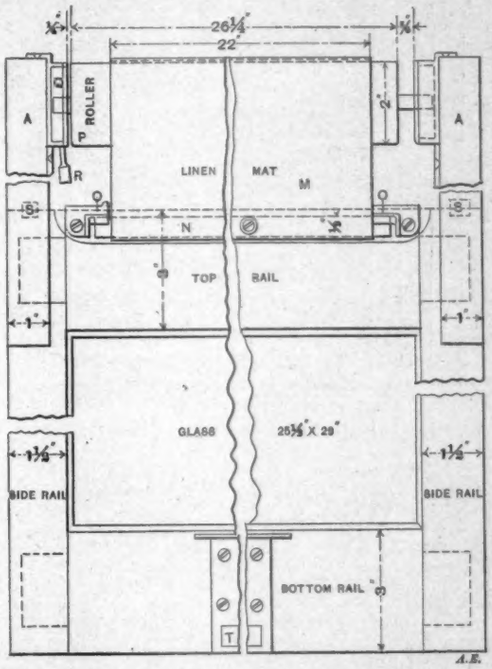


Fig. 1—Car Window Equipped With Edwards Window Fixtures.

end to the top rail of the window by a brass strip, N, held in position by two small clamps, O. The upper end of the mat is wound around the roller, P, which is given sufficient tension to lift the sash when the sash is free to move. To regulate the tension of the roller there is a worm gear shown in Fig. 2, which is manipulated by the screw, R, Fig. 1. By pressing slightly together a pair of thumb-catches placed on the window sill, the sash will travel steadily upward until it strikes the top of the frame, where two rubber stops S, are placed. By means of friction strips pressing against the side rails of the window and operated by the thumb-catch, the window can be opened to any desired height. In connection with the thumb-catch is a small bar which slides into the slot, T, when the window is closed, and locks it in that position. These friction strips, adjusting themselves as they do, keep any dust or cold air from entering the car, and also take up any shrinkage or swelling of the wood, thus preventing the sash from binding and allowing it to move freely when the pressure is removed. This device adds greatly to the comfort and good-will of passengers, as everyone must know who has the good fortune to ride in cars equipped with it.

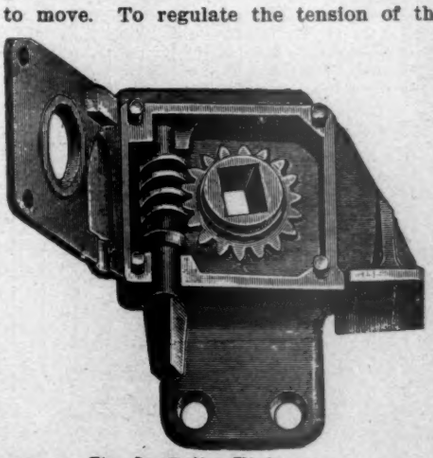


Fig. 2.—Roller Tightener.

TESTS OF THE BOILER OF THE PURDUE LOCOMOTIVE.

By W. F. M. Goss.

The results obtained from a series of 35 tests on the boiler of the Purdue locomotive are of rare importance and will be valuable in future matters having to do with locomotive boilers. These tests were made as part of the regular work of the senior students in Mechanical Engineering, at the Purdue Locomotive Testing Laboratory, and are recorded by Professor Goss in an admirable paper before the American Society of Mechanical Engineers, of which the following is a condensed presentation. The locomotive upon which the tests were made is now known as "Schenectady No. 1," and is of the 8-wheel type, having a total weight of 85,000 lbs. The boiler, which is designed to carry a pressure of 140 lbs., is of the ordinary crown bar type with a narrow firebox and no brick arch. It has a

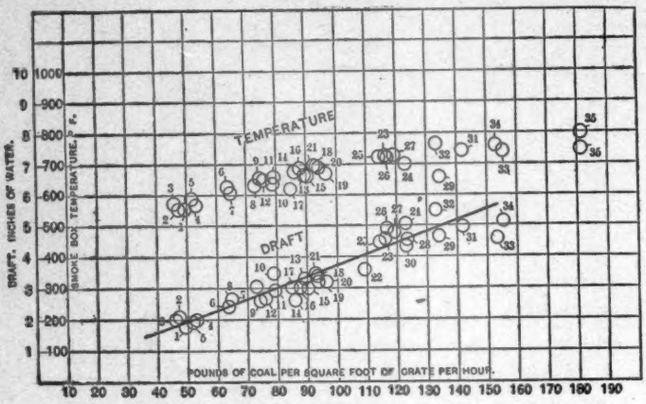


Fig. 1.—Coal, Draught and Smoke Box Temperature.

total heating surface of 1,347 sq. ft., of which 132.1 sq. ft. is in the firebox and 1,204.3 sq. ft. in the tubes. The grate area is 17.25 sq. ft., the ratio of heating surface to grate area 7.81, and the ratio of steam space to entire cubical capacity of the boiler is 0.29.

These tests were run immediately following the re-establishment of the testing plant, after its damage by fire, in February, 1894.

The results presented are averages obtained from observations taken at five-minute intervals. In most cases the individual observations were checked by two different observers using separate instruments, or they have been taken by one observer and checked by some form of automatic recording instrument. All derived results have been calculated by two or more independent workers.

Evaporation.

In actual evaporation one test shows that nearly 15,000 lbs. of water were delivered to the boiler and presumably evapo-

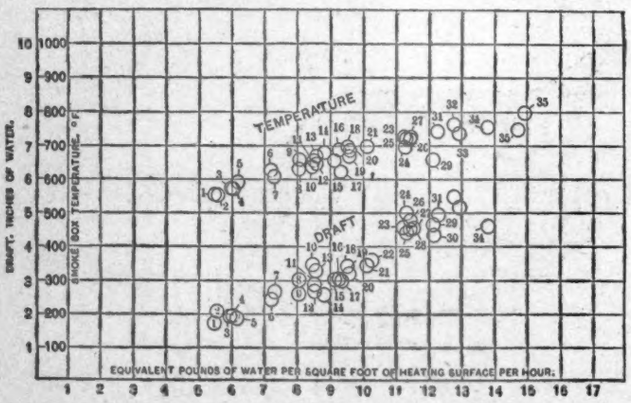

DRAFT, INCHES OF WATER.
SMOKE BOX TEMPERATURE, °F.
TEMPERATURE
DRAFT
EQUIVALENT POUNDS OF WATER PER SQUARE FOOT OF HEATING SURFACE PER HOUR.

Fig. 2.—Water, Draught and Smoke Box Temperature.

rated each hour, or, approximately, 250 lbs. per minute. This rate of very nearly a barrel a minute is sufficient to evaporate an amount of water equal to the full water capacity of the boiler in 34 minutes. At this rate, had the injectors ceased in their action, the water level would have fallen between the upper and the middle gauges at the rate of 1 in. each minute.

The quality of the steam is shown to improve as the rate of evaporation is increased, although variations in individual results are so great that they do not fall in any well-defined line. It has been shown by Professor Jacobus that almost all moisture which may be intermixed with steam passing a horizontal pipe separates itself from the steam by gravitation, and forms a rill in the bottom of the pipe, the steam above being approximately dry. Experiments by the writer, involving a visual examination of the steam space of the boiler while in action, revealed no haze or mist above the surface of the water, thus sustaining the conclusion that the steam within the steam space of the boiler is ordinarily dry and saturated; the water is present as water, and the steam as steam. They are not intermixed. If this is true, the steam which passes the throttle of a locomotive should be expected to be dry, and it would be entirely so if it were not that the violence of the circulation projects small beads of water upward, far beyond the general surface. Some of these enter the throttle with the steam. This action explains why the moisture increases with the power of the boiler, and makes it not unreasonable to assume that the purity of the water in the boiler may actually affect the quality of the steam. The comparative dryness of the steam under all conditions is a fact worthy of emphasis, for the locomotive is often credited with carrying over a great deal of water to the cylinders. The tests show that this does not happen under constant conditions of running. When it

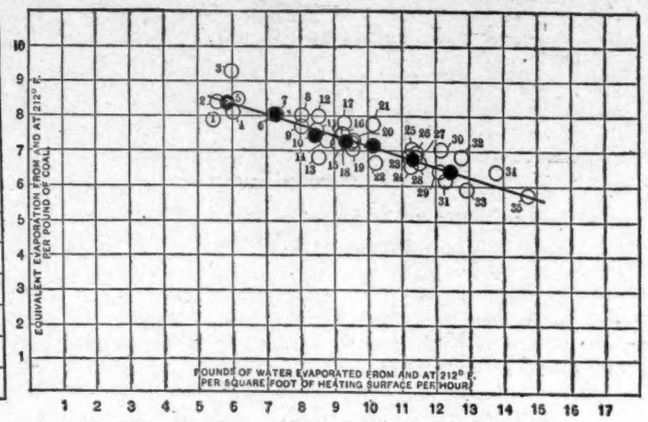

EQUIVALENT EVAPORATION FROM AND AT 212° F. PER POUND OF COAL.
POUNDS OF WATER EVAPORATED FROM AND AT 212° F. PER SQUARE FOOT OF HEATING SURFACE PER HOUR.

Fig. 3.—Rate of Evaporation and Efficiency.

occurs it is probably the result of too high a water level or of a sudden demand upon the boiler.

Power of Boiler.

The water evaporated per foot of grate surface varies from less than 400 to more than 1,000 lbs. per hour. These figures reflect well the intensity of the furnace action, which must provide for the combustion of sufficient fuel to produce such a result. Similarly the weight of water evaporated per square foot of heating surface varies from 5½ to nearly 15 lbs. per hour, the maximum rate being nearly the equivalent of a boiler horse-power for every 2 ft. of heating surface in the boiler.

Coal and Combustible.

The coal used for all tests was Indiana block and the amount fired per hour is between the limits of 729 lbs. and 3,133 lbs.

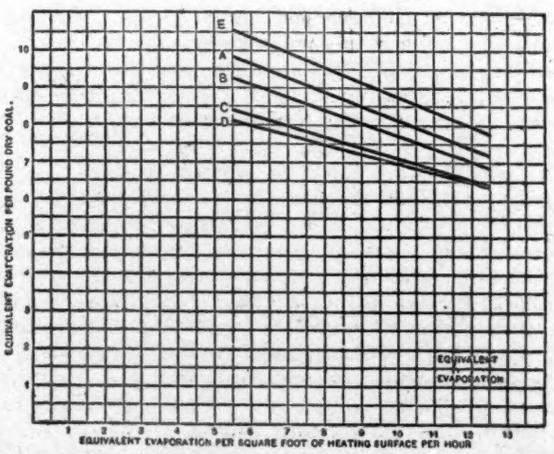


Fig. 4.—Evaporation and Efficiency for Five Samples of Coal.

Five tests have a rate of less than half a ton per hour, and twelve have a greater rate than one ton per hour. The rate per square foot of grate per hour ranges from 49 to 182, values—the significance of which appears when it is considered that in naval service, under forced draught, the rate seldom exceeds 60 lbs. per hour. The coal burned per foot of heating surface per hour varies from 0.7 to 2.6 lbs.

Draft, Ratio of Combustion and Smoke-Box Temperature.

For the tests reported, the average draft varies from 1.7 ins. to 7.5 ins. Other things being equal, the capacity of the jet as a means for producing draught is nearly proportional to the weight of steam discharged per unit of time.

The relation of reduction of pressure in the smoke-box to coal burned per square foot of grate surface is well shown by Fig. 1, and the relation of pressure reduction in smoke-box,

and evaporation per square foot of heating surface by Fig. 2. The first diagram, Fig. 1, represents the effect of changes in the draught condition, on combustion, and the second (Fig. 2) upon the evaporative power of the boiler. In both diagrams the points representing individual tests fall irregularly. An approximation to the mean curve, representing draught and rate of combustion, is shown by the straight line (Fig. 1) which is represented by the equation,

$$D = .037\,G \qquad (1)$$

in which D is the draught in inches of water, and G is the pounds of coal per square foot of grate per hour.

The smoke-box temperature, as affected by changes in the rate of combustion, is shown by Fig. 1, and as affected by changes in the rate of evaporation by Fig. 2. From these figures it will be seen that as the power of the boiler is increased the smoke-box temperature rises; also that, as in the case of the draught, the points representing individual tests fall irregularly. It should be noticed, however, that the smoke-box temperature is lower than it is usually assumed to be. It varies from 550 degrees to 798, a range which, considering the variation in the rate of combustion, is not great. Ideal conditions should make the smoke-box temperature a function of the rate of combustion, but under actual conditions the relationship, as it appears in Fig. 1, is not without variation. Smoke-box temperatures, plotted with evaporation, are given in Fig. 2. As evaporation is more directly a function of the heat passing the tubes than of furnace action, this comparison does not necessarily involve inequalities in the action of the grate. For this reason the points should be expected to fall more nearly in line, but at the scale chosen for the diagram it must be confessed that the actual difference is not great.

Evaporative Performance.

Table I. shows the actual evaporation per pound of dry coal (column 40) to vary from 6½ lbs. of water for the lightest power test to 4.77 for the heaviest. Columns 41 and 42 show respectively the evaporation from and at 212 degrees Fahr. for each pound of dry coal, assuming the quality of the steam to be that shown by the calorimeter, and assuming all steam generated to have been dry and saturated. In a similar manner columns 43 and 44 show the equivalent evaporation per pound of combustible. Referring to the equivalent evaporation per pound of coal as it would ordinarily be calculated (column 41), it will be seen that for the lightest power test the evaporation was 7.83 lbs. of coal, and that it is diminished greatly, but somewhat irregularly, as the rate of evaporation increases, until, when the power of the boiler becomes maximum, it is reduced to 5.71, a loss of 27 per cent. The equivalent evaporation per pound of coal for the several tests (column 41) and the rate of evaporation, as represented by the pounds of water evaporated per foot of heating surface per hour are

TABLE I.

Consecutive Number.	Duration of Test in Minutes	Evaporation. Equivalent Evap. from and at 212° F. Per Pound of Dry Coal. Total Water divided by total Coal.	Assuming quality of Steam as shown by Column.	Assuming all Water delivered to have been completely evaporated into Dry Steam.	Per Pound of Combustible. Assuming quality of Steam as shown by Column.	Assuming all Water delivered to have been completely evaporated into Dry Steam.
1	4	40	41	42	43	44
1	240	6.50	7.83	7.86	8.70	8.7
2	190	6.90	8.31	8.35	9.24	9.28
3	180	7.67	9.15	9.26	10.17	10.29
4	255	6.70	8.05	8.10	8.95	9.00
5	180	6.98	8.37	8.44	9.31	9.38
6	180	6.63	7.95	8.00	8.84	8.89
7	240	6.61	7.95	7.99	8.84	8.88
8	180	6.44	7.74	7.99	8.61	8.66
9	180	6.31	7.61	7.66	8.45	8.51
10	140	6.26	7.54	7.58	8.38	8.42
11	180	6.26	7.54	7.58	8.38	8.42
12	150	6.62	7.96	7.99	8.83	8.88
13	170	5.62	6.75	6.79	7.50	7.54
14	120	6.00	7.17	7.24	7.95	8.04
15	160	5.95	7.12	7.20	7.92	8.00
16	170	6.19	7.41	7.48	8.24	8.31
17	170	6.44	7.72	7.80	8.58	8.66
18	180	5.99	7.18	7.23	7.98	8.04
19	120	5.83	6.98	7.03	7.76	7.81
20	160	5.98	7.18	7.25	7.97	8.05
21	120	6.40	7.68	7.75	8.54	8.62
22	120	5.51	6.59	6.66	7.33	7.40
23	150	5.69	6.81	6.86	7.57	7.63
24	180	5.40	6.47	6.53	7.18	7.26
25	180	5.79	6.94	7.00	7.72	7.78
26	140	5.75	6.87	6.95	7.63	7.73
27	160	5.63	6.74	6.80	7.49	7.56
28	120	5.50	6.59	6.65	7.32	7.39
29	160	5.31	6.35	6.42	7.06	7.13
30	120	5.82	6.95	7.03	7.73	7.81
31	140	5.09	6.09	6.14	6.77	6.83
32	122.5	5.64	6.76	6.83	7.51	6.57
33	120	4.86	5.86	5.90	6.52	6.55
34	68	5.31	6.34	6.40	7.04	7.11
35	120	4.77	5.71	5.76	6.36	6.39

plotted in Fig. 3. From the points of this diagram an effort has been made to locate a curve which should show the relation of the evaporative efficiency to the rate of evaporation. The method adopted may be described as follows:

The several points were separated into nine groups, those of each group representing tests of nearly the same power. The grouping is as follows:

1st group, (test) 1, 2, 3, 4, 5; 2d group, (test) 6, 7; 3d group, (test) 8, 9, 10, 11, 12, 13, 14; 4th group, (test) 15, 16, 17, 18, 19, 20; 5th group, (test) 21, 22; 6th group, (test) 23, 24, 25, 26, 27, 28; 7th group, (test) 29, 30, 31, 32, 33; 8th group, (test) 34; 9th group, (test) 35.

The centers of the first seven groups have been determined and their location is shown on the diagram by solid black spots. A straight line drawn as nearly as possible through the points thus located is assumed to show the relationship sought. There are but two centers of groups that are as much as 1 per cent. away from this line, and four touch it within one-tenth of one per cent. Before attempting a more critical examination of the line thus located, we may inquire why so many of the joints representing individual tests and shown

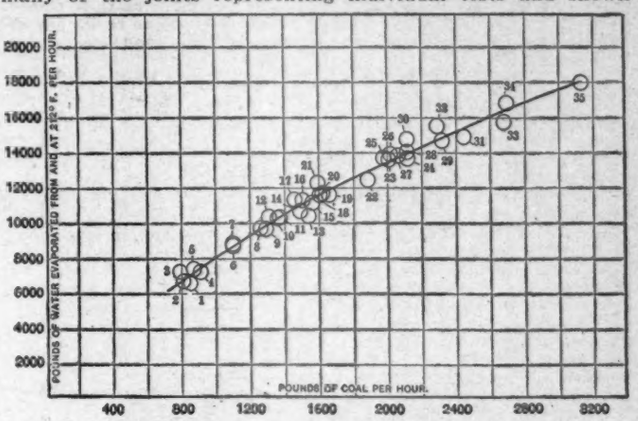


Fig. 5.—Combustion and Evaporation.

upon the diagram by light circles, fall at so great a distance from it. The facts in the case are as follows:

11 points or 31% of the whole agree with the curve within 1%
15 points or 43% of the whole agree with the curve within 2%
18 points or 51% of the whole agree with the curve within 3%
21 points or 60% of the whole agree with the curve within 4%
24 points or 69% of the whole agree with the curve within 5%
27 points or 77% of the whole agree with the curve within 6%

There is a widespread feeling among motive-power men that the character of the exhaust has much to do with the efficiency of the furnace action; that a heavy exhaust incident to slow running will have a different effect upon the fire than the lighter but more rapid action attending higher speeds, though the draft, as registered by a gauge in the smoke-box, may read the same. It was but natural, therefore, to first look to the engine conditions for an explanation of the irregularities in the efficiency of the boiler. The result of such a study tends to disprove the commonly accepted theory, and justifies the conclusion that, with a given vacuum in the smoke-box, the action of the boiler is quite independent of the manner in which the vacuum is maintained, whether by slow heavy beats or quicker, lighter pulsations.

Thus a comparison of the 11 tests that agree with the mean curve (Fig. 3) within 1 per cent. with the 11 tests which have the greatest divergence from it, reveals the fact that the tests of the latter class are, for the most part, those in which the firing of the boiler was difficult. The greater part of the tests of this group are either tests at very low power, for which only a light fire could be maintained without danger of losing steam at the safety valve, or tests at high speeds, when the

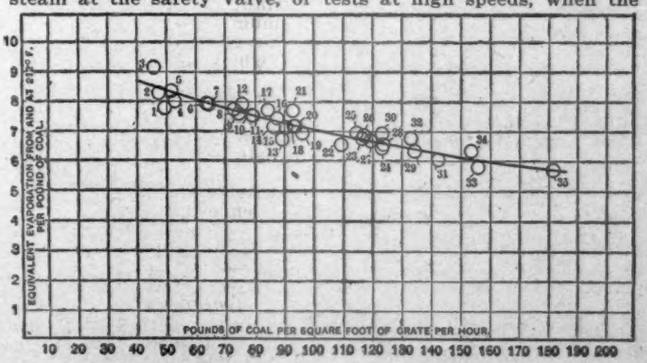


Fig. 6.—Rate of Combustion and Efficiency.

work of firing was hard and difficult. Included in this group also is one test under low boiler pressure, which is to be regarded as a light power test. On the other hand, those which agree most nearly with the curve are, for the most part, tests at medium load, which were easily fired.

Power and Efficiency.

Referring again to Fig. 3, it will be noted that the ordinates in this diagram represent the evaporative efficiency of the boiler, and the abscissae the rate of evaporation. The manner

in which the line assumed to represent the mean of these points was drawn has already been described. The equation for the line is

$$E = 10.08 - .296\ H \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

in which E is the pounds of water evaporated from and at 212 degrees per pound of coal, and H the pounds evaporated per square foot of heating surface per hour. This equation and others derived from it are assumed to represent the average performance of the boiler when using Indiana block coal. By its use it is possible to obtain a coal record from the water rate, no weighing being done of the fuel as consumed. Defence for such a practice is to be found in the comparative ease with which the water record is obtained, and in the fact that the coal consumption, as determined from the equation, is a more consistent factor than can ordinarily be obtained experimentally from a few tests. The form of the equation will doubtless hold for all boilers of similar design with that tested, but the constants may change with the proportions of the boiler, and will of necessity change with the character of the fuel employed.

Efficiency as Affected by Quality of Fuel.

The evaporation obtained from 5 different samples of fuel, designated as A, B, C, D and E, is shown in Fig. 4. In this connection it is of interest to note that the lines E, A, B, C, D converge, and it may be assumed that if D and C were sufficiently extended they would meet; that is, if the rate of evaporation were made sufficiently high, both the good and the poor coal would give the same evaporation.

The general conclusion deduced is that the higher the power to which a boiler is forced, the smaller is the fraction of the total heat developed which can be absorbed by the heating surface. If forced to very high power, the amount of heat utilized out of all that is available becomes so small that slight variations in the amount available do not measurably affect the amount utilized. If carried to extreme limits, it will doubtless appear that the line represented by equation 2, Fig. 3, is in fact not straight, though, within limits which are sufficiently broad to cover all practical cases, it may probably be so considered. The form of this, and other similar lines, is the subject of discussion in a preceding paragraph.

Derived Relations.

Fig. 5 shows the relation between the rate of evaporation and the rate of combustion for the 35 tests. The relation of water evaporated per pound of coal and pounds of coal consumed per ft. of grate per hour is shown by Fig. 6.

Conclusions.

1. The steam delivery by the boiler, tested under constant conditions of running, as shown by calorimeter attached to dome, is at all times nearly dry, the entrained moisture rarely equaling 1.5 per cent., and being generally much less than this. While the relationship can not be perfectly defined, it appears that the entrained moisture increases slightly as the rate of evaporation is increased.

2. The maximum power at which the boiler was worked with Brazil block coal was such as gave 30-boiler horse-power for each foot of grate, and .427 horse-power for each foot of heating surface. Experiments with other fuels indicate that these values may be increased by the use of a better coal by about 15 per cent., giving maximum values, which, in round numbers, are 35 horse-power per foot of grate and .5 horse-power per foot of heating surface. For the type of boiler experimented upon, and under conditions of constant running, these values may be accepted as near the maximum.

3. The maximum rate of combustion reached was 182 pounds of coal per foot of grate per hour, which is equivalent to 2.6 pounds per foot of heating surface.

4. The maximum draft for any test was that for which the average value was 7.5 inches. If D is the reduction of pressure in the smoke-box measured in inches of water, and G the pounds of coal burned per foot of grate per hour, then

$$D = .037\ G.$$

Also, if W be the total weight of water evaporated per hour, the draft necessary to produce a given evaporation is represented by the equation,

$$D = \frac{.00214\ W}{10.08 - .000244\ W}.$$

These equations apply to the boiler tested when using Indiana block coal.

5. Smoke-box temperature ranges from 550 degrees Fahr. to 800 degrees Fahr., values which are lower than those which are often assumed to prevail.

6. The evaporative efficiency of the boiler as affected by different rates of evaporation is expressed by the equation,

$$E = 10.08 - .296\ H,$$

in which E is the pounds of water evaporated from and at 212 degrees per pound of coal, and H the pounds of water evaporated from and at 212 degrees per square foot of heating surface per hour; this for the boiler tested using Indiana block coal, and for values of H of not less than 5 or greater than 15. By different coals the constants will vary, results which are near the minimum being expressed by

$$E_{min.} = 9.4 - .024\ H,$$

and results near the maximum by

$$E_{max.} = 12.9 - .041\ H.$$

7. The evaporative efficiency of the boiler as affected by different rates of combustion is expressed by the equation,

$$E = \frac{10.08}{1 + .00421\ G},$$

in which E, as before, is the pounds of water evaporated from and at 212 degrees per pound of coal, and G the pounds of coal burned per foot of grate per hour; this for the boiler tested using Indiana block coal.

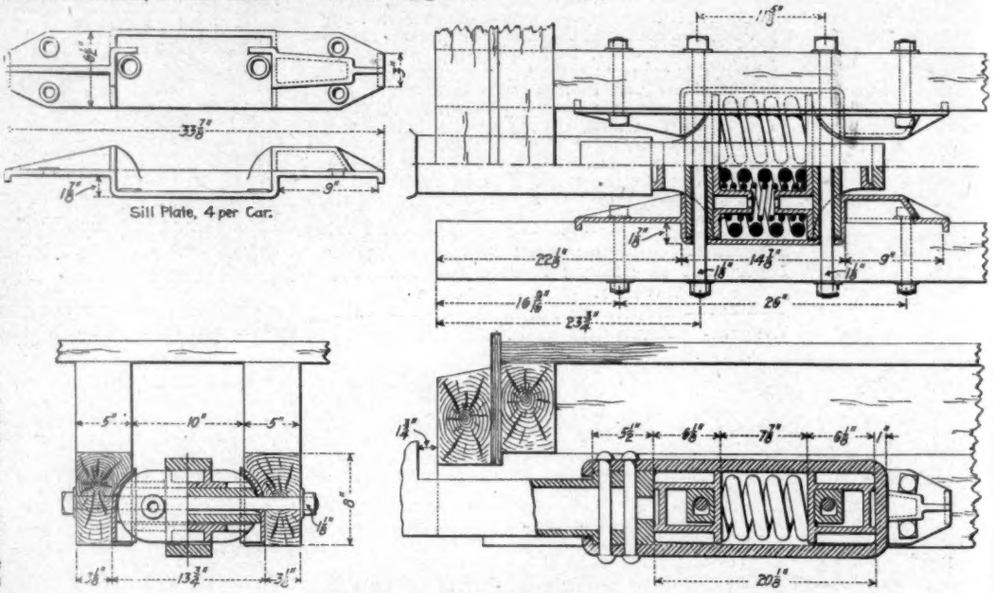
8. The relation of coal burned to water evaporated is expressed by the equation,

$$C = \frac{W}{10.08 - .000244\ W},$$

in which C is the total pounds of coal burned per hour, and W the total pounds of water evaporated from and at 212 degrees per hour; this for the boiler tested using Indiana block coal.

9. The condition of running the engines, whether with long or short cut-off, or at high or low speed, does not appear to affect the efficiency of the boiler of a locomotive, except in so far as it affects the average value of the draft.

10. The efficiency of the boiler of a locomotive, as disclosed by two different tests, for which all conditions of running are the same, may vary considerably, due doubtless to inequalities in the firing.



The Dayton Twin-Spring Draft Gear.

THE DAYTON TWIN-SPRING DRAFT GEAR.

To meet the demand for draft gear of increased strength and capacity, a new design employing twin springs has been placed on the market by the Dayton Malleable Iron Company. It is adapted to both steel and wooden cars and to wooden and malleable-iron draft sills, the arrangement for wooden sills being illustrated in the accompanying engraving.

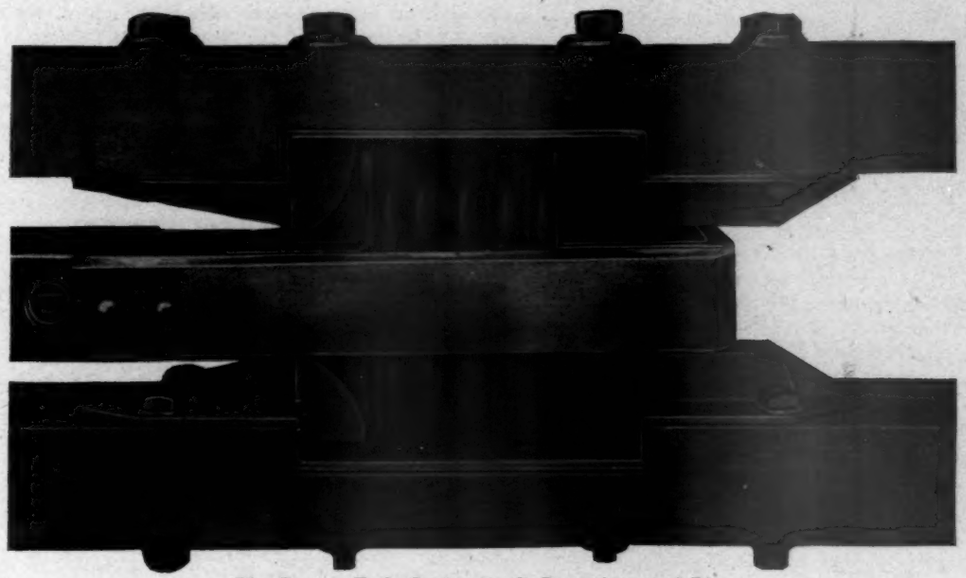
The essentials are sill plates, stop bars and followers. The sill plates are gained into the draft timbers to a depth of 1⅞ ins. and secured to them by four bolts each. Each sill plate has a lip at each end, gained into the draft sills, giving four points at which the stresses are received. The length of the sill plates, 34 ins., distributes the strains over a large area, and they are not concentrated at any one point. Their length also renders the frictional resistance between the plates and the sills important.

The stop bars are rectangular and are cast with an opening through the center. They remain in a stationary position and are rigidly secured to the sill plates and draft timbers by a 1⅛-in. bolt which extends through each stop bar, sill plate, and draft sill. The only duty of these bolts is that of binding the

draft sills together and carrying the weight of the back end of the coupler, the tail strap and springs.

Each follower has a rectangular horizontal opening through which the stop bars are passed. In a perpendicular direction the opening is made with sufficient clearance to allow the followers free movement, while in a horizontal direction it is made 2⅛ ins. greater than the width of the stop bar. Each spring is supported at its ends by a boss cast on each follower. The length of these bosses is such that while the springs are without load the distance between the bosses is 1⅞ ins. A travel of 2 ins. is required to close the springs, and therefore the bosses come in contact before the spring is fully closed.

Under buffing strains the rear stop bar receives the load and the forward follower travels loosely over its stop bar and compresses the springs. The forward stop bar receives all pulling strains, and it may be noted that the sill plates are both heavily ribbed for withstanding strains in the direction in which they



The Dayton Twin-Spring Draft Gear—Inverted Plan.

are applied. These ribs extend inwardly to a point beyond the center of each spring, and therefore the strains applied to the stop bars and followers are crushing strains. The ribs on the rear end of each sill plate form a box which gives great strength and at the same time furnishes a guide to prevent the tail strap having too much side play.

In working out this design three objects have been sought, namely, to eliminate bending and shearing strains; to keep the number of parts at the minimum; and to bind the draft sills together. These objects seem to have been attained. The bending and shearing strains which are so destructive have been reduced to direct crushing strains. The rigging complete per car, as furnished by the makers, consists of four sill plates, four stop bars and four followers. This leaves the railroad to furnish only two tail straps, four springs and 20 bolts per car. Special attention is directed to the fact that the bolts which pass through the stop bars bind the draft sills rigidly against spreading. This is essential to the success of draft rigging. Many failures are caused by the draft timbers being forced apart and split or broken, owing to the side and twisting strains, which many forms of draft gear are not designed to meet.

The special claims made for the rigging are that it can be easily and quickly inspected, all parts being in plain view; that it can be quickly put up and taken down, and also that it can be applied to a car at a lower cost than any other good double rigging. This draft gear is fully protected by patents, and is manufactured and sold by the Dayton Malleable Iron Company, Dayton, Ohio.

The proceedings of the Western Railway Club for November, 1900, contain interesting references to this draft gear, which was one of the most successful in meeting the rigorous punishment described by Mr. Sanderson in his paper which we referred to on page 374 last month. In the discussion of the paper Mr. Street stated that in a service test a car loaded with 55,700 lbs. of scrap iron was thrown against another similarly loaded with 51,600 lbs., both having the Dayton draft gear. The speed in one test was as high as 16.4 miles per hour, and while the cars were rendered unfit for further service, the damage to the draft gear was confined to a slight bending of the followers and stop bars.

Two tests in the 300,000-lb. testing machine at Purdue University were also recorded. The loads were applied to the end of the coupler with the knuckle removed, and although the capacity of the machine was exhausted in the case of the malleable draft sills, the rigging was yet in condition to be used after the test. And when a load of 250,000 lbs. was left on the rigging for 12 hours, after the test, the permanent set was but 0.65 in. and one follower plate was cracked and bent and the stop bars were slightly bent. A test on the draft gear with wooden sills developed a strength of the draft rigging exceeding that of the sills. The draft rigging withstood a load of 220,000 lbs. without producing a failure of a single part of the draft gear proper.

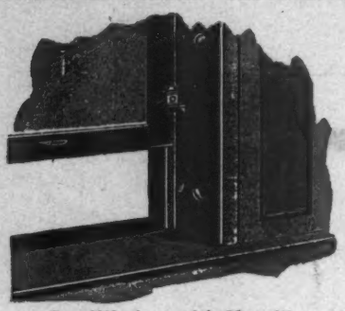
Wherever double spring draft gear has been used the number of failures of draft attachments and couplers have been reduced materially and there is no doubt that a material and necessary addition of strength may be obtained in this way. On one road, having 700 cars equipped with the Dayton draft gear in use since last March, the draft gear and coupler failures are reported to "amount to practically nothing." Thus far there have been no reported failures of this gear employing malleable draft sills, and the opinion that these are necessary in wooden cars is undoubtedly growing.

Mr. A. B. Burtis has resigned from the Lowe Brothers Company, where he had charge of their railway department, and has connected himself with the Mamolith Carbon Paint Company as general manager. This company will manufacture, extensively, carbon and other paints for railroads, electric roads, bridges, marine and structural work. Their dry color plant is located in the West and offices and works for grinding in New York and Cincinnati. We are informed on good authority that this company have inexhaustible mines of a high-grade carbon, which pigment has been in the hands of experts for several years. Fully 2,000 comparative tests have been made—besides a large number of buildings have been painted with it during the past few years—but they have demonstrated beyond question its value as a pigment. Mr. Burtis has a very large experience in manufacturing and selling all kinds of paints, especially for railroad uses, is well known among railway people and is thoroughly acquainted with the necessities of their work.

METAL WINDOW CASINGS.

Applied to Railway Cars and Locomotive Cabs.

Those who have had to do with car and cab windows have undoubtedly felt the need of a window casing that is weather proof, dust proof, rattle proof and in which the sash can be moved with perfect ease at all times without regard to the state of the weather. The metallic window casing shown in the engraving is perfectly simple; two elastic metallic casings are secured to the window frame, and grooves made in the sash to fit the rounded edges of the metallic casings. The grooves embrace the sides of the sash between the two elastic casings with sufficient pressure to make a tight joint, on both the inner and outer sides of the sash, excluding fine cinders, wind and cold and yet always moving with perfect freedom and ease. This casing can be applied to car windows of any style, old or new, and at an expense that is small, as compared with the great advantage derived from their application. It is also applied to locomotive cabs, steamships and dwelling houses. The finish it gives is pleasing and adds greatly to the general appearance of the window.



Car Window with Metallic Casings.

This invention is secured by patents owned by the Metallic Window Casing Company, who are prepared to sell the right to use and furnish the material ready to be applied to any form or style of window, and guarantee their perfect operation. Information will be furnished upon application to the Metallic Window Casing Company, 154 Congress street, Boston, Mass.

"Where the New Century Will Really Begin" is the title of a small pamphlet received from the Joseph Dixon Crucible Company. This very interesting article is by John Ritchie, Jr., and is a reprint from the Ladies' Home Journal. The latter part of the booklet is taken up with the evolution of school pencils, pointing out the improvements witnessed in the last half century in the equipment of public education. It starts back with the day of the "plummet," a bit of soft lead, which was hammered out into stick form. The Joseph Dixon Crucible Company has sought to find the best graphite ores for pencil making that the earth afforded, and the softest, straightest-grained wood for casings. They have used their every effort that the leads in their pencils might be a little smoother, a little tougher and a little blacker.

Locomotive Sanders.—A catalogue of the devices controlled and manufactured by the American Locomotive Sander Company has been distributed for the purpose of explaining their action and increasing the convenience of ordering. Reliance is now placed upon sanders in order to increase the starting power of heavy locomotives, and their development has become an important factor in modern improvements. These devices serve to place the sand where it is needed, to give a constant supply delivered automatically, and economize in sand by avoiding waste. Incidentally they also serve to reduce tire and rail wear. They have also become very important in the stopping of heavy trains with the air brake, and thus contribute not a little to the safety of railroad operation. This pamphlet of 30 pages brings the subject up to date and shows the most approved apparatus to meet all conditions of service; the Leach "A," "B" and "D" sanders, the "She" sander, and also Sherburne's arrangement for automatic sanding used in connection with the air-brake valve. The engravings are unusually fine in execution and the best use has been made of transparent views, whereby the construction and methods of attachment are clearly brought out. Copies of the catalogue will be sent upon application to the American Locomotive Sander Company, Philadelphia, Pa.

SMALL STEEL CASTINGS AND THE TROPENAS PROCESS.

Until recently the manufacturers of cast steel have not sought orders for small castings because of the difficulty of securing satisfactory work, especially when the patterns are intricate. The Sargent Company of Chicago, for example, has preferred large work, but last March this concern adopted the Tropenas process and installed it at their works at Chicago Heights, Ill., whereby small castings may be made. Good results are insured and it may be expected that many machinery parts formerly forged will now be made of cast steel. It appears that this process is an important metallurgical improvement.

This method was adopted after several years of experience with open-hearth and crucible steel plants, and after a careful study of the subject of steel-making at home and abroad, where the Tropenas process is in successful operation in some forty different plants. The Tropenas process consists in the use of special converters in which pig iron and selected scrap, previously melted in a cupola, are subjected to an air-blast of 3 to 4 lbs. pressure per square inch, directed horizontally across the top of the molten bath. This action generates intense heat by the combustion of the metalloids in the pig iron, and after a period varying from 16 to 20 minutes, depending on the quantity of the charge used, there remains in the converter a bath of nearly pure iron. Addition is made of ferro-manganese or ferro-silicon, or both, to bring up the silicon, manganese and carbon contents to the specified proportions, when the metal is drawn off into a ladle and poured. The process is very simple and the product very regular.

The peculiar advantage claimed for the Tropenas process is that the resultant metal is much better and consequently more fluid than that produced by any other method, and it is this which makes it valuable in the manufacture of small and intricate castings, as it can be poured over the lip of the ladle in as small a stream as desired, and will run through thin sections, producing solid castings free from pinholes and cracks. Any grade of metal is readily produced by varying the additions. It is consequently valuable not only in the production of low carbon steel of the maximum permeability, so much desired in electrical castings, but also in the production of special grades of hard steel for mining machinery parts and other purposes.

The plant at Chicago Heights is in successful operation, producing from 20 to 30 tons of castings per day, with a much larger available capacity. All classes of general machinery, railroad, mining and electrical castings, are turned out, believed to be fully equal in physical properties and chemical composition to the best open-hearth steel. The castings are sound and solid, with a smooth surface, and the metal will stand forging and welding.

Miscellaneous castings, unless otherwise specified, are made of mild steel which is tough and machines readily, having a tensile strength per square inch of from 65,000 to 75,000 with an elongation of 20 to 30 per cent. Tropenas steel castings are solid and true to pattern, equalling in every respect the forgings which they are intended to replace, and they can be furnished in much less time and at a lower cost, especially where special dies and appliances for forging must be made.

Wherever possible, all patterns are molded by machinery, which insures uniformity. Every attention is devoted to securing the best result both in quality and workmanship. All kinds of work in the shape of special castings for automobile construction, general railroad, mining, electrical and machinery parts, where lightness and strength are desired, can be made in Tropenas steel.

Information on the subject of small and special steel castings, from one pound in weight up, may be had by addressing the Sargent Company, Old Colony Building, Chicago, Ill.

A special money card is being sent out by the American School of Correspondence, Boston, Mass., to be used by engineers and others desiring to examine their instruction papers and text books. The card contains a place where a silver twenty-five-cent piece may be inserted and securely sealed. This card contains, also, a place for name and address and the text book wanted. It can be placed in an envelope and addressed to the school without further trouble. Anyone wishing to examine any of the instruction papers of this school should send for one of these cards in order to send the money safely.

BOOKS AND PAMPHLETS.

Proceedings of the Thirty-first Annual Convention of the Master Car and Locomotive Painters' Association. Held at Detroit, Mich., September, 1900. Published for the Association by the Railroad Car Journal, New York, 1900.

This volume contains, in addition to the constitution, list of officers and members and rules of order, the proceedings and discussions of many interesting papers. It is bound in cloth and has 148 pages with an index. Copies can be procured from the Secretary, Mr. Robert McKeon, Erie Railroad, Kent, Ohio.

Injectors: Their Theory, Construction and Working. By W. W. F. Pullen, Professor of Engineering at the South Western Polytechnic, London, S. W. Second edition, illustrated. New York: D. Van Nostrand Company, 23 Murray Street. 1900. Price, $2.00.

Very little printed information upon the subject of injectors is at hand. Those books treating of the steam engine as a whole or in part seem to fall short when they come to the subject of injectors. This volume of 187 pages, illustrated, is devoted entirely to the construction and working of injectors. In order that the reader may follow more appreciatively the different stages of development of the steam injector, the author has reserved the historical portion until he has discussed at some length the theory. The first chapter opens with a popular explanation of the action of the steam injector, which is followed by a mathematical investigation of the velocity of efflux of the steam jet. The exhaust injector, while similar to the ordinary live steam apparatus, except in dimensions, has been treated separately, together with compound injectors and the ejector condenser. The whole book is given a very consecutive arrangement which will assist those who may not be quite familiar with the mathematics used in the discussion. In this second edition advantage has been taken to describe and illustrate the latest patterns of injectors. The illustrations are not good, but the book as a whole is the most complete we have seen. It is, however, written from the English standpoint.

Progress of Invention in the Nineteenth Century. By Edward W. Byrn, A. M. Large octavo, 480 pages, illustrated. Munn & Company, 361 Broadway, New York. 1900. Price, $3.

This is a collection of thirty-five chapters upon progress in as many different directions, in the century now closing. It is popular in style and, while necessarily rather fragmentary, because of its scope, it is a book one will often find convenient in fixing the dates of discoveries or inventions which mark turning-points in the world's progress. The work contains a chronological record of the leading inventions based upon the Patent Office documents. The subject matter may be divided into several general heads, such as electricity, steam, printing, development of machinery, medicine, lighting, engineering, textile machinery, artificial ice, liquid air and minor inventions. It does not pretend to be exhaustive, but it does present the "state of the art" in each chapter and marks the contrast which shows what has been accomplished in this century. In a number of the chapters one recognizes engravings which have appeared in the pages of the Scientific American, but the book is not in any sense a reprint from that journal.

Catechism on the Combustion of Coal and Preventing of Smoke. A Practical Treatise for Engineers, Firemen and Others Interested in Fuel Economy and Suppression of Smoke from Stationary Boilers and Locomotives. By William M. Barr, M. E. Pages, 350, illustrated. Published by Norman W. Henley & Company, 132 Nassau Street, New York, 1900. Price, $1.50.

This book places before engineers and firemen at a moderate price an excellent treatment of the subject of combustion from the standpoints of economical use of fuel and prevention of smoke. The form of a catechism was adopted because of its directness and compactness of expression. It does not pretend to be a work for mechanical engineers, yet it will be convenient for reference with regard to fuels and a number of recent improvements in furnaces made with a view of smokeless and economical combustion. The author aimed to make the work complete in itself and evidently did not intend it for a text-book for continuous study, but rather a reference book in which to look up the various phases of the general subject of combustion. The divisions into chapters are as follows: Fuels, elementary data, the atmosphere, combustion, products of combustion, heat developed by combustion, fuel analysis, heating power of fuels, steam generation, stationary furnace details, locomotive furnace details, chimneys and mechanical draft and spontaneous combustion. In the part devoted to the locomotive the author has included instructions to firemen as adopted by the mechanical department of the C., N. O. & T. P. R. R., the devices for smoke prevention of the Locomotive Smoke Preventer Company, the brick arch, the Strong and Wootten boilers, Mr. Quereau's papers on exhaust arrangements, the Southern Pacific front end and fire door, and the methods of the Southern Pacific Railway in burning liquid fuel. The treatment of the subject is what would be expected of a writer who is competent to treat his subject for the mechanical engineer and who adapts his style and information to the needs of men who manage boilers and are not necessarily men of high education. The book will probably have a large sale. It will be valuable to all who use steam or are responsible for its economical generation.

Specifications for Steel Bridges. By J. A. Waddell, M. Am. Soc. C. E. Published by John Wiley & Sons, New York, 1900.

This volume of 178 pages is practically a reproduction of chapters XIV. to XIX. inclusive, of Mr. Waddell's "De Pontibus," which was published nearly three years ago. They have been extended and modified somewhat so as to bring them up to the latest railroad requirements and best shop practice. The subjects treated in this book are as follows: General specifications governing the designing of steel bridges and viaducts and the superstructure of elevated railroads, specifications for railroad draw-spans, general specifications governing the designing of steel highway bridges and viaducts, specifications for highway draw-spans, general specifications governing the manufacture, shipment and erection of steel bridges, trestles, viaducts and elevated railroads, and the compromise system of live loads for railway bridges and the equivalents. There are also eighteen tables useful to the draughtsman and the designer and ten diagrams of engine loadings, equivalent uniform loads, etc. A complete index of twenty-two pages adds value to the book. Besides the usual specifications for bridges, much additional information is given that will be of value to engineers who have not had the years of experience which the author shows by his treatment of the subject. There are points, however, which will arouse criticism among engineers; for instance, the paragraphs covering the spacing for guard-timbers on railroad bridges. The clause covering the spacing of the inner guard-timber requires 5 ins. clear between gauge-plan of main rail and outer face of guard-timber; also the outer guard-timbers are placed with 12 ins. between gauge-plane of main rail and inner face of guard-timber.

Mr. Ira G. Hedrick, Consulting Engineer, Kansas City, Mo., says: "We have been using these specifications exclusively in our practice for nearly four years, and we find that they are complete in every particular, and are applicable to steel bridges of all types, lengths and loadings. In my opinion, they are the most thorough, concise and complete specifications yet published. This conclusion is based upon several years of actual use, and after having employed a great many other bridge specifications."

EQUIPMENT AND MANUFACTURING NOTES.

The New York Central is to order 100 new locomotives to meet the demands of increased business.

The steel rail manufacturers in Pittsburg authorize the announcement that they have contracted to furnish fully 1,000,000 tons of steel rails in 1901. Some of the manufacturers have already contracted to the utmost limit of their plants for the next six months. The New York Central has placed an order for 80,000 tons of steel rails to be delivered early in the year.

The Richmond Locomotive Works has just secured an order from the Norfolk & Western Railroad for 10 Class "W" 21 by 30-in. consolidation locomotives with piston valves. The principal dimensions of these engines are as follows: Driving wheels, 56 ins.; driving wheel base, 15 ft. 6 ins.; total wheel-base, 23 ft. 11 ins.; weight in working order, about 170,000 lbs.; weight on drivers, 150,000 lbs.; capacity of tank, 5,000 gallons.

In order to provide facilities for conducting its rapidly increasing local business, the B. F. Sturtevant Company has just removed its Chicago office to much larger quarters at 281-289 South Clinton Street.

The Paris agent of the Rand Drill Company reports that the compressors and drills which were exhibited at the exposition have been sold. The large Corliss compound compressor which supplied compressed air to all the American exhibits at Vincennes was purchased by the firm of Messrs. J. & A. Niclausse, the manufacturers of the Niclausse water-tube boilers, by whom it is to be used for the operation of pneumatic tools in their extensive establishment.

A recent issue of the "Jernbanebladet," a railroad journal published in Sweden, reports that the 20-in. and 31-in. by 24-in. two-cylinder compound 10-wheeled freight locomotives, which the Swedish State Railways purchased from the Richmond Locomotive Works during 1899, are so satisfactory that the Railway Administration has decided to adopt the Richmond system of compounding on their lines, and have ordered 29 compound engines of that type to be built in their own shops. This is a good achievement for American locomotives, which are gradually working their way into all countries of the world.

The Richmond Locomotive Works have just received an order from the Chesapeake & Ohio Railway Company for 25 22-in. by 28-in. Class G-6 consolidation locomotives, making 50 engines in all of the same type and design. These engines are exact duplicates of the 25 machines the Richmond Works now have under construction for the C. & O. Ry. The principal dimensions are: Cylinders, 22 ins. by 28 ins.; drivers, 56 ins.; driving wheel base, 17 ins.; total wheel-base, 25 ft. 3 ins.; diameter of boiler, 70 ins.; steam pressure, 200 lbs.; weight on drivers, 165,000 lbs.; total weight, 184,000 lbs.; total weight of tender loaded, 103,000 lbs.; tender, 6,000 gallons capacity.

The large addition to the machine shop and the new building provided for the brass foundry, boxing and brass polishing department of the Bullock Electric Manufacturing Company, which are nearing completion, will increase the floor space and improve the facilities to such an extent that the capacity of the works will be nearly doubled. Many large contracts have been recently received from both home and abroad, and this company states that the present outlook for business during 1901 is even better than during the past four years. Their bulletin No. 37, issued recently, shows numerous views in these works and the various types of machines manufactured; also a large list of the purchasers of the Bullock apparatus.

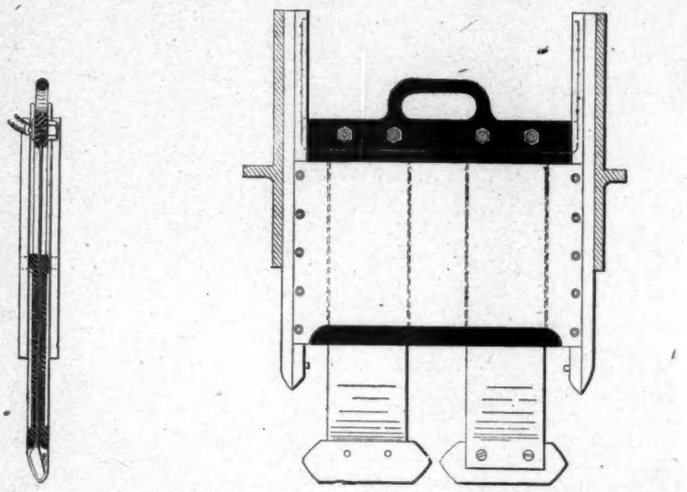
Mr. Walter B. Snow, of the B. F. Sturtevant Company, Boston, Mass., in a recent address in that city, summed up the features of the blower system of mechanical draft for heating and ventilating as follows: "The entire heating surface is centrally located, inclosed in a fireproof casing and placed under the control of a single individual, thereby avoiding the possibility of damage by leakage or freezing, incident to a scattered system of steam piping and radiators. The heater itself is adapted for the use of either live or exhaust steam, and provision is made for utilizing the exhaust of the fan engine, thereby reducing the cost of operation to practically nothing. At all times ample and positive ventilation may be provided with air tempered to the desired degree. Absolute control may be had over the quality and quantity of air supplied. It may be filtered and cleansed, heated or cooled, dried or moistened at will. By means of the hot and cold system, the temperature of the air admitted to any given apartment may be instantly and radically changed without the employment of supplementary heating surface. The pressure created within the building is sufficient to cause all leakage to be outward, preventing cold inward drafts and avoiding the possibility of drawing air from any polluting source within the building itself. By returning the air, using live steam in the heater and operating the fan at maximum speed, a building may be heated up with great rapidity. The area of heating surface is only one-third to one-fifth that required with direct radiation, while the primary cost and operating expenses of a fan is far less than that of any other device for moving the same amount of air."

ELECTRIC CONDUIT APPLIED TO CABLE RAILWAYS.

The K. A. K. Systems.

In this system the conduit rails are supported on channels which are secured to cast-iron yokes. Steel plates are placed directly upon the top of the yoke with one side turned at right angles to form the drip into the conduit. The insulators support malleable castings, on which lips are provided to close around the conduit feeder tubing, which is of iron pipe lined with treated wood.

The conductor rails are bolted to malleable castings, and the conductors are bonded at the ends by heavy flexible copper strips. Provision is made for contraction and expansion in the joints, and also for slight movements of the insulators. The trolley contacts are made by two springs of flat steel on spring bases. They carry cast-iron shoes on their lower ends for making contact with the conductor rails, and as they are simple and inexpensive, renewals may be cheaply made. The springs are carried in opposite directions at their lower ends; they pass through and are supported in insulating material, which is protected by the steel covering, this being fitted loosely in



the base, which is permanently secured to the car truck. The springs are fastened at the top by means of the insulating fiber strips and pass loosely through the insulations of the casing.

The trolley is raised from the slot by means of the handle on the top of the insulating strip. This raises the springs and draws the shoes away from the conductor rails and brings them together at the bottom of the casing. The casing and the shoes are then drawn from the slot. In this system manholes are provided from 300 to 500 ft. apart. In these the fuse connections are placed and provisions are made for draining the conduit into the sewer. The fuse connections are made with heavy copper wire on insulated screw handles which may be readily detached or replaced without danger. The conductor rails end at the manholes and at these points they are connected to the feeders through the fuses. This construction renders it easy to locate defective insulation, it also prevents disabling the whole line or large part of the line because a grounding of one of the conductors disables one section only. With the return feed system electrolysis and its serious consequences are entirely prevented.

Besides this conduit system, which is owned and controlled by Mr. O. S. Kelley, A. S. Krotz and W. P. Allen, these gentlemen have a covered third-rail system, both of which are fully protected by United States patents. Information concerning the system may be obtained from Mr. O. S. Kelley, Springfield, Ohio.